

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

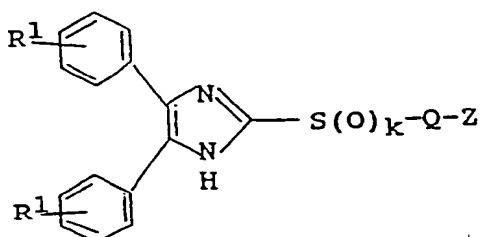


Bi
433960

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁵ : C07D 233/84, A61K 31/415 C07D 405/12, 403/12</p>	<p>A1</p>	<p>(11) International Publication Number: WO 91/13876 (43) International Publication Date: 19 September 1991 (19.09.91)</p>
<p>(21) International Application Number: PCT/GB91/00408 (22) International Filing Date: 15 March 1991 (15.03.91) (30) Priority data: 9005966.8 16 March 1990 (16.03.90) GB (71) Applicant (for all designated States except US): RHONE-POULENC RORER LIMITED [GB/GB]; Rainham Road South, Dagenham, Essex RM10 7XS (GB). (72) Inventors; and (75) Inventors/Applicants (for US only): BRIDGE, Andrew, William [GB/GB]; COFFEE, Edward, Charles, John [GB/GB]; HARRIS, Neil, Victor [GB/GB]; LYTHGOE, David, John [GB/GB]; SMITH, Christopher [GB/GB]; Rhône-Poulenc Rorer Limited, Rainham Road South, Dagenham, Essex RM10 7XS (GB).</p>		<p>(74) Agents: BENTHAM, Stephen et al.; J.A. Kemp & Co, 14 South Square, Gray's Inn, London WC1R 5LX (GB). (81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US. Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</p>

(54) Title: IMIDAZOLES



(II)

BEST AVAILABLE COPY

(57) Abstract

Imidazole derivatives of general formula (II) in which R¹ is hydrogen or one or more substituents, k is 0, 1 or 2, Q is a straight or branched alkylene group and Z is hydrogen or a substituent group and pharmaceutically acceptable salts thereof possess useful pharmacological properties as inhibitors of acyl coenzyme-A: cholesterol-o-acyl transferase and as inhibitors of the binding of thromboxane TXA₂ to its receptors, and are useful in therapy.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland			SN	Senegal
CI	Côte d'Ivoire	KR	Republic of Korea	SU	Soviet Union
CM	Cameroon	LI	Liechtenstein	TD	Chad
CS	Czechoslovakia	LK	Sri Lanka	TG	Togo
DE	Germany	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		

- 1 -

IMIDAZOLES

The present invention relates to new therapeutically useful imidazole derivatives, to a process for their preparation, to pharmaceutical compositions containing them, and to their use as pharmaceuticals.

The imidazole derivatives of the present invention are the compounds of the general formula:-



wherein A represents a group of general formula II shown hereinafter in the present specification, wherein the symbols R^1 may be the same or different and each represents hydrogen or one or more substituents, for example substituents selected from halogen atoms, and straight- or branched-chain alkyl and alkoxy groups containing from 1 to about 6 carbon atoms, and trifluoromethyl groups;

k represents 0, 1 or 2;

Q represents a methylene group or alkylene chain containing from 2 to about 5 carbon atoms, optionally substituted with one or more alkyl groups containing from 1 to about 4 carbon atoms; and

Z represents a hydrogen atom; a hydroxy group; an alkoxy group optionally substituted by, for example, an alkoxy or alkoxyalkoxy group; an aryl, for example phenyl, group optionally substituted by, for example,

- 2 -

one or more alkoxy, e.g. methoxy, groups; a dialkyl-amino group wherein the alkyl groups may be the same or different and each is straight- or branched-chain and contains from 1 to about 4 carbon atoms; a group of the formula -NHR^2 , wherein R^2 represents an acyl group, for example a straight- or branched-chain alkanoyl group containing up to about 6 carbon atoms and which may be substituted, for example, by a carboxy group, or R^2 represents a group of the formula $\text{-C(SR}^3\text{)=N-CN}$ wherein R^3 represents a straight- or branched-chain alkyl group containing from 1 to about 3 carbon atoms, or R^2 represents a 5- or 6-membered nitrogen-containing heterocyclic ring optionally substituted by one or more substituents selected from, for example, amino groups and straight- or branched-chain alkyl groups containing from 1 to about 3 carbon atoms, and preferably attached to the group -NH via a carbon atom; or Z represents a group of the formula -COR^4 wherein R^4 represents a straight- or branched-chain alkyl group containing from 1 to about 3 carbon atoms; a group of the formula -CH(OH)R^5 , -COR^5 , -CSR^5 , -CONHR^5 or -CSNHR^5 wherein R^5 represents a 5- or 6-membered nitrogen-containing heterocyclic ring which may also contain an oxygen atom, optionally substituted by one or more substituents selected from, for example, straight- or branched-chain alkyl groups containing from 1 to about 3 carbon atoms; an alkynyl or cycloalkyl group

- 3 -

containing up to about 6 carbon atoms; a group of the formula $-\text{CH}(\text{R}^6)\text{OR}^7$ wherein R^6 represents a straight- or branched-chain alkenyl or alkoxy group containing up to about 6 carbon atoms and R^7 represents a straight- or branched-chain alkyl group containing from 1 to about 4 carbon atoms, optionally substituted by one or more substituents selected from, for example, hydroxy groups; a group of the general formula III shown hereinafter, wherein m is 0 or 1, n is 0 or 1 and p is 1, 2 or 3, and the symbols R^8 each represent a hydrogen atom, or a methyl group substituted by a straight- or branched-chain alkoxy or alkanoyloxy group containing up to about 6 carbon atoms; a group of the general formula IV shown hereinafter wherein m is as hereinbefore defined; a group of the general formula V shown hereinafter wherein R^9 represents a hydrogen atom or a straight- or branched-chain alkyl group containing from 1 to about 4 carbon atoms and R^{10} represents a hydrogen atom or a hydroxy group or a straight- or branched-chain alkyl group containing from 1 to about 4 carbon atoms; or a group of the general formula VI shown hereinafter wherein R^9 is as hereinbefore defined; a group of the general formula VII shown hereinafter wherein R^9 and R^{10} are as hereinbefore defined, the symbols R^{11} may be the same or different and each represents a hydrogen atom or a

- 4 -

hydroxy group and R^{12} represents a hydrogen atom or a straight- or branched-chain alkyl group containing from 1 to about 4 carbon atoms; or a group of the formula $-CH(OH)CH_2(CR^9R^{10})_rCH_2COR^{13}$ wherein R^9 and R^{10} are as hereinbefore defined, r represents 0 or 1 and R^{13} represents a hydroxy group or a straight- or branched-chain alkoxy or alkylamino group containing from 1 to about 4 carbon atoms; and pharmaceutically acceptable salts thereof.

In this specification alkyl groups and moieties, unless otherwise specified, are straight- or branched-chain and contain from 1 to about 6 carbon atoms.

(2S, 4R, 6S)-6-[(4,5-Diphenylimidazol-2-yl)-thiomethyl]-4-hydroxy-2-methoxy-3,4,5,6-tetrahydro-2H-pyran and (2R, 4R, 6S)-6-[(4,5-diphenylimidazol-2-yl)-thiomethyl]-4-hydroxy-2-methoxy-3,4,5,6-tetrahydro-2H-pyran are excluded from the scope of this invention.

Especially important features of the present invention are, or involve, compounds of general formula I wherein at least one of the symbols has a value selected from the following:-

- (i) the symbols R^1 may be different or, preferably, the same and each represents a hydrogen or halogen, e.g. chlorine or fluorine, atom or a straight- or branched-chain alkyl group containing from 1 to 6, preferably from 1

- 5 -

to 4, carbon atoms, or a straight- or branched-chain alkoxy group containing from 1 to 3 carbon atoms, e.g. methoxy, or a trifluoromethyl group;

(ii) k represents 0;

(iii) Z represents a hydrogen atom; a hydroxy group; an alkoxy, e.g. ethoxy, group optionally substituted by, for example, an alkoxyalkoxy, e.g. methoxyethoxy, group; an aryl, for example phenyl, group optionally substituted by, for example, one or more alkoxy, e.g. methoxy, groups; a dialkylamino group wherein the alkyl groups may be the same or different and each is straight- or branched-chain and contains from 1 to 4, preferably from 1 to 3, carbon atoms; an ethynyl group, or a cycloalkyl, e.g. cyclohexyl, group;

(iv) R^2 represents an acyl group, for example a straight- or branched chain alkanoyl group containing up to about 6 carbon atoms and which may be substituted, for example, by a carboxy group; or a pyridyl or triazolyl group optionally substituted by one or more, preferably one or two, substituents selected from amino groups and straight- or branched-chain alkyl, e.g. methyl, groups;

- 6 -

- (v) R^3 represents a methyl group;
 - (vi) R^4 represents a methyl group;
 - (vii) R^5 represents a imidazolyl, morpholinyl or pyridyl group optionally substituted by one or two alkyl, e.g. methyl, groups;
 - (viii) R^6 represents an allyl group, or an alkoxy group containing from 1 to 3 carbon atoms, e.g. methoxy or ethoxy;
 - (ix) R^7 represents an alkyl group containing from 1 to 3 carbon atoms, e.g. methyl or ethyl, optionally substituted by a hydroxy group;
 - (x) R^8 represents a hydrogen atom or a hydroxymethyl, methoxymethyl or acetoxymethyl group;
 - (xi) R^9 represents a hydrogen atom or a methyl group;
 - (xii) R^{10} represents a hydrogen atom or a hydroxy or methyl group;
 - (xiii) R^{12} represents a hydrogen atom or a methyl group; and/or
 - (xiv) R^{13} represents an alkoxy or alkylamino group containing from 1 to 4 carbon atoms;
- the other symbols being as hereinbefore defined, and pharmaceutically acceptable salts thereof.

- 7 -

Particularly important features of the present invention are, or involve, at least one of the following compounds:-

- A 2-(2-ethoxyethylthio)-4,5-diphenylimidazole
- B 2-[(dioxolan-2-yl)methylthio]-4,5-diphenylimidazole
- C 2-benzylthio-4,5-diphenylimidazole
- D 2-(3,5-dimethoxybenzylthio)-4,5-diphenylimidazole
- E 2-cyclohexylmethylthio-4,5-diphenylimidazole
- F [±]-2-[(tetrahydro-2H-pyran-6-yl)methylthio]-4,5-diphenylimidazole
- G [±]-2-[(tetrahydro-2H-pyran-6-yl)methylthio]-4(5)-(4-chlorophenyl)-5(4)-phenylimidazole
- H 2-[2-(1,3-dioxan-2-yl)ethylthio]-4,5-diphenylimidazole
- I 2-[3-(1,3-dioxan-2-yl)propylthio]-4,5-diphenylimidazole
- J 2-(2,2-diethoxyethylthio)-4,5-diphenylimidazole
- K 2-(2,2-dimethoxyethylthio)-4,5-diphenylimidazole
- L 2-(3,3-diethoxypropylthio)-4,5-diphenylimidazole
- M 2-(4-ethoxyhex-5-enylthio)-4,5-diphenylimidazole
- N 2-[4-(2-hydroxyethyl)hept-6-enylthio]-4,5-

- 8 -

- diphenylimidazole
- O 2-(2-oxoprop-1-yl)thio-4,5-diphenylimidazole
- P 2-(2-diethylaminoethylthio)-4,5-diphenyl-
imidazole
- Q 2-(2-diisopropylaminoethylthio)-4,5-diphenyl-
imidazole
- R 2-propargylthio-4,5-diphenylimidazole
- S [±]-4,5-bis(2-chlorophenyl)-2-[(tetrahydro-2H-
pyran-2-yl)methylthio]imidazole
- T [±]-4(5)-(2-chlorophenyl)-5(4)-phenyl-2-[(tetra-
hydro-2H-pyran-2-yl)methylthio]imidazole
- U [±]-4(5)-(3-chlorophenyl)-5(4)-phenyl-2-
[(tetrahydro-2H-pyran-2-yl)methylthio]imidazole
- V [±]-2-[(1,4-dioxanyl)methylthio]-4,5-diphenyl-
imidazole
- W [±]-2-[(2,2-di(methoxymethyl)tetrahydro-2H-
pyran-6-yl)methylthio]-4,5-diphenylimidazole
- X 2-(3-dimethylaminopropylthio)-4,5-diphenyl-
imidazole
- Y 2-(3,6,9-trioxadecylthio)-4,5-diphenylimidazole
- Z [±]-2-[2,2-di(hydroxymethyl)tetrahydro-2H-pyran-
6-ylmethylthio]-4,5-diphenylimidazole
- AA [±]-2-[2,2-di(acetoxymethyl)tetrahydro-2H-
pyran-6-ylmethylthio]-4,5-diphenylimidazole
- AB 2-(2-hydroxyethylthio)-4,5-diphenylimidazole
- AC 2-ethylthio-4,5-diphenylimidazole

- 9 -

- AD 2-[(1,3-dioxan-2-yl)methylthio]-4,5-diphenyl-
imidazole
- AE 3-cyano-2-methyl-1-[3-(4,5-diphenylimidazol-2-
ylthio)propyl]isothiourea
- AF 2-[2-(5-amino-1,2,4-triazol-3-ylamino)ethyl-
thio]-4,5-diphenylimidazole dihydrochloride
- AG 3-cyano-2-methyl-1-[4-(4,5-diphenylimidazol-2-
ylthio)butyl]isothiourea
- AH 2-[4-(5-amino-1,2,4-triazol-3-ylamino)butyl-
thio]-4,5-diphenylimidazole
- AI 2-[3-(5-amino-1,2,4-triazol-3-ylamino)propyl-
thio]-4,5-diphenylimidazole
- AJ 3-cyano-2-methyl-1-[2-(4,5-diphenylimidazol-2-
ylthio)ethyl]isothiourea
- AK N-(4-methylpyrid-2-yl)-4-(4,5-diphenyl-
imidazol-2-ylthio)butanamide
- AL 4,6-dimethyl-2-[4-(4,5-diphenylimidazol-2-yl-
thio)butylamino]pyridine
- AM 2-(3-acetamidopropylthio)-4,5-diphenylimidazole
- AN 2,6-dimethyl-N-[4-(4,5-diphenylimidazol-2-yl-
thio)butan-1-yl]morpholine
- AO N-(4,6-dimethylpyrid-2-yl)-4-(4,5-diphenyl-
imidazol-2-ylthio)butanamide
- AP N-(pyrid-2-yl)-4-(4,5-diphenylimidazol-2-
ylthio)butanamide
- AQ (5R,5S)-4,5-diphenyl-2-[(2-oxotetrahydrofur-5-

- 10 -

- yl)methylthio]imidazole
- AR (4R,4S) (6R,6S) -6-[(4,5-bis{3-chlorophenyl}imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one
- AS (4R,4S) (6R,6S) -6-[(4,5-Bis{4-chlorophenyl}-imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyl-tetrahydropyran-2-one
- AT (4R,4S) (6R,6S) -6-[(4,5-Bis{2-chlorophenyl}-imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyl-tetrahydropyran-2-one
- AU (4R,4S) (6R,6S) -6-[(4,5-Bis{4-fluorophenyl}-imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyl-tetrahydropyran-2-one
- AV (4R,4S) (6R,6S) -6-[(4,5-Bis{4-trifluoromethylphenyl}imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one
- AW (4R,4S) (6R,6S) -4-Hydroxy-6-[(4,5-bis{3-methylphenyl}imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one
- AX (4R,4S) (6R,6S) -4-Hydroxy-6-[(4,5-bis{4-methylphenyl}imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one
- AY (4R,4S) (6R,6S) -4-Hydroxy-6-[(4,5-bis{4-isopropylphenyl}imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one
- AZ (4R,4S) (6R,6S) -6-[(4,5-Bis{4-tertbutylphenyl}-

- imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyl-tetrahydropyran-2-one
- BA (4R,4S) (6R,6S)-4-Hydroxy-6-[(4,5-bis(2-methoxyphenyl)imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one
- BB (4R,4S) (6R,6S)-4-Hydroxy-6-[(4,5-bis(3-methoxyphenyl)imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one
- BC 6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one
- BD 6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one
- BE 4-hydroxy-6-[(4,5-bis(4-methoxyphenyl)imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one
- BF 4-hydroxy-6-[(4,5-bis(4-methoxyphenyl)imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one
- BG (6R,6S)-6-[(4,5-bis(4-methylphenyl)imidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one
- BH (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one
- BI (6R,6S)-6-[(4,5-Bis(4-chlorophenyl)imidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one
- BJ (6R,6S)-6-[(4,5-bis(3-chlorophenyl)imidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one
- BK (6R,6S)-6-[(4,5-bis(2-chlorophenyl)imidazol-

- 12 -

- 2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one
- BL (6R,6S)-6-[(4,5-bis-{4-fluorophenyl}imidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one
- BM (5R,5S)-5-[(4,5-bis-{4-methylphenyl}imidazol-2-yl)thiomethyl]tetrahydrofuran-2-one
- BN (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-3,4,5,6-tetrahydropyran-2-one
- BO (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4,4-dimethyl-3,4,5,6-tetrahydropyran-2-one
- BP (4R,4S) (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-3,4,5,6-tetrahydropyran-2-one
- BQ (3R,3S) (5R,5S)-ethyl 6-[(4,5-diphenylimidazol-2-yl)thio]-3,5-dihydroxyhexanoate
- BR (6R,6S)-[(4,5-diphenylimidazol-2-yl)thiomethyl]-2-oxo-1,4-dioxane
- BS t-butyl 6-[(4,5-bis-{4-chlorophenyl}imidazol-2-yl)thio]-3,5-dihydroxy-3-methylhexanoate
- BT (3R,3S) (5R,5S)-ethyl 6-[(4,5-diphenylimidazol-2-yl)thio]-3,5-dihydroxy-3-methylhexanoate
- BU (2R,2S)-2-[(2-hydroxy-4,4-dimethyl-5-methylaminocarbonylpent-1-yl)thio]-4,5-diphenylimidazole
- BV (2R,2S) (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-2-hydroxy-3,4,5,6-tetrahydropyran

- BW (2R,2S) (4R,4S) (6R,6S) -6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-2,4-dihydroxy-4-methyltetrahydropyran
- BX (2R,2S) (4R,4S) (6R,6S) -6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-2-methoxy-4-methyl-tetrahydropyran (2-alpha-anomer)
- BY (2R,2S) (4R,4S) (6R,6S) -6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-2-methoxy-4-methyl-tetrahydropyran (2-beta-anomer)
- BZ (2S,3R,4R,5S,6S) -2-[(4,5-diphenylimidazol-2-yl)thiomethyl]-6-methoxy-3,4,5-trihydroxytetrahydropyran
- CA 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-1-methylimidazole
- CB 2-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-1-methylimidazole
- CC 2-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]-1-methylimidazole
- CD 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-imidazole
- CE 2-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]-imidazole
- CF 2-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-imidazole
- CG 2-[4-(4,5-diphenylimidazol-2-ylthio)-1-hydroxybutyl]-1-methylimidazole

- 14 -

CH	2-[6-(4,5-diphenylimidazol-2-ylthio)-1-hydroxy-hexyl]-1-methylimidazole
CI	2-[5-(4,5-diphenylimidazol-2-ylthio)-1-hydroxy-pentyl]-1-methylimidazole
CJ	2-[4-(4,5-diphenylimidazol-2-ylthio)-1-hydroxy-butyl]imidazole
CK	2-[5-(4,5-diphenylimidazol-2-ylthio)-1-hydroxy-pentyl]imidazole
CL	2-[6-(4,5-diphenylimidazol-2-ylthio)-1-hydroxy-hexyl]imidazole
CM	4-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-morpholine
CN	4-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-morpholine and
CO	4-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]-morpholine.

The letters A to CO are allocated to the compounds for easy reference.

As will be apparent to those skilled in the art, many of the compounds of formula I may exist in more than one enantiomeric form. All such compounds, and their mixtures, are within formula I and within the scope of the present invention.

- 15 -

The compounds according to the invention are inhibitors of acyl coenzyme-A:cholesterol-O-acyl transferase (ACAT; EC 2.3.1.26). They are therefore of value as anti-atherosclerotic agents and have utility in the treatment of atherosclerosis, hyperlipidaemia, cholesterol ester storage disease and atheroma in vein grafts.

They are also inhibitors of the binding of thromboxane TxA_2 to its receptors. They are therefore of utility in the treatment of conditions such as thrombosis and myocardial infarction, vasospastic disorders, for example associated with angina, and bronchospasm, for example associated with asthma, or in reperfusion salvage therapy, for example after ischaemic injury.

Compounds within the scope of the present invention exhibit positive pharmacological activities as demonstrated by the following in-vitro and in-vivo tests which are believed to correlate to pharmacological activity in humans and other animals.

In in-vitro tests on human platelet membrane, compounds of the invention produced up to 50% inhibition of the binding of thromboxane TxA_2 to its receptors at concentrations down to about 600 nanomolar or less.

- 16 -

In assays performed in-vitro, microsomes, obtained from the livers of rats fed on a diet supplemented with 0.5%w/w cholesterol and 0.25%w/w cholic acid for 7 days, were incubated with radiolabelled oleoyl-CoA in the presence of compounds according to the invention at a concentration of 0.5 or 1 μ g/ml. The degree of ACAT inhibition produced was up to 90% or more.

In in-vivo tests, using rats fed on a similar diet to that above and further supplemented by 0.03% w/w of test compound, the compounds according to the invention inhibited increases in plasma cholesterol concentrations, measured after 3 days, relative to control animals fed on the cholesterol supplemented diet without the drug, by up to 90% or more.

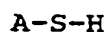
- 17 -

Compounds of formula I can be prepared by the application or adaptation of known methods, for example methods illustrated in the following Examples and Reference Examples.

The intermediates and starting materials from which they are prepared can also be prepared by the application or adaptation of known methods.

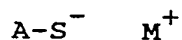
By the term "known methods" is meant methods known heretofore or described in the literature.

For example, as a feature of the present invention, compounds of formula I, wherein k is 0 and the other symbols are as hereinbefore defined, are prepared by the reaction of a compound of the general formula:-



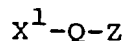
VIII

wherein A is as hereinbefore defined, or a salt thereof, of the general formula:-



IX

wherein A is as hereinbefore defined and M represents an alkali metal, with a compound of the general formula:-



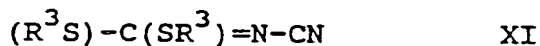
X

or a salt thereof, wherein X^1 is a group displaceable by a thiolate salt, such as a halogen e.g. a chlorine, bromine or iodine, atom or an alkyl- or aryl-

- 18 -

sulphonyloxy group (e.g. methanesulphonyloxy or 4-toluenesulphonyloxy) and Q and Z are as hereinbefore defined. The reaction is generally carried out in an inert organic solvent such as tetrahydrofuran, dimethylformamide, a lower alkanol such as methanol or ethanol, at a temperature from ambient to 110°C and optionally in the presence of a proton acceptor, such as an amine (e.g. triethylamine or pyridine) or an alkali metal hydroxide, carbonate or alkoxide. The salt of formula IX or the compound of formula X can optionally be prepared in situ by the application or adaptation of known methods.

According to a further feature of the invention, compounds of formula I wherein k is 0 and Z represents a group of the formula $\text{-NH-C(SR}^3\text{)=N-CN}$, A, Q and R^3 being as hereinbefore defined, are prepared by the reaction of compounds of the general formula:-



wherein R^3 is as hereinbefore defined with compounds of the general formula:-



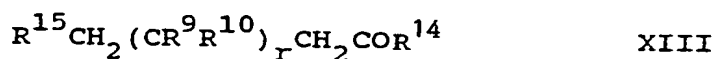
wherein A and Q are as hereinbefore defined.

According to a further feature of the invention, compounds of formula I wherein k is 0 and Z represents a group of the formula -NHR^2 wherein R^2 represents an acyl group, A and Q being as hereinbefore defined, are

- 19 -

prepared by the acylation by known methods of compounds of formula XII as hereinbefore defined, for example by reaction with the appropriate acid anhydride or acid halide.

According to a further feature of the invention, compounds of formula I wherein k is 0 and Z represents a group of the formula $-\text{CH}(\text{OH})\text{CH}_2(\text{CR}^9\text{R}^{10})_r\text{CH}_2\text{COR}^{14}$ wherein R^9 , R^{10} and r are as hereinbefore defined and R^{14} represents a straight- or branched-chain alkoxy group containing from 1 to 4 carbon atoms, A and Q being as hereinbefore defined, are prepared by the reaction of a compound of formula IX as hereinbefore defined, optionally prepared in situ, with a compound of the general formula:-



wherein R^9 , R^{10} , r and R^{14} are as hereinbefore defined and R^{15} represents a 1,2-epoxyethyl group, in an inert solvent such as methanol.

According to a further feature of the present invention, compounds of general formula I are prepared by the interconversion of other compounds of general formula I.

For example, compounds of formula I wherein k is 0 and Z represents a group of formula IV wherein m is 0 or Z represents a group of formula V wherein R^9 and R^{10} are as hereinbefore defined, A and Q being as

- 20 -

hereinbefore defined, are prepared by the cyclisation of compounds of formula I wherein k is 0 and Z represents a group of the formula

$$-\text{CH}(\text{OH})\text{CH}_2(\text{CR}^9\text{R}^{10})_r\text{CH}_2\text{COR}^{14}, \text{A}, \text{Q}, \text{R}^9, \text{R}^{10}, r \text{ and } \text{R}^{14}$$

being as hereinbefore defined. The cyclisation can be carried out by reaction with a base, e.g. sodium methoxide in methanol, followed by reaction with trifluoroacetic acid.

Conversely, compounds of formula I wherein k is 0 and Z represents a group of the formula

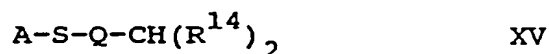
$$-\text{CH}(\text{OH})\text{CH}_2(\text{CR}^9\text{R}^{10})_r\text{CH}_2\text{COR}^{14}, \text{A}, \text{Q}, \text{R}^9, \text{R}^{10}, r \text{ and } \text{R}^{14}$$

being as hereinbefore defined, are prepared by the hydrolysis and esterification of compounds of formula I wherein k is 0 and Z represents a group of formula IV wherein m is 0 or Z represents a group of formula V wherein R^9 and R^{10} are as hereinbefore defined, A and Q being as hereinbefore defined, for example by reaction with a base, e.g. an aqueous solution of an alkali metal hydroxide, e.g. sodium hydroxide, followed by reaction of the resulting salt with the appropriate alkyl halide.

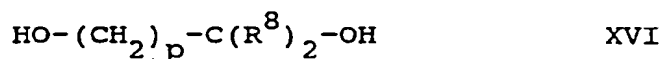
As another example, compounds of general formula I wherein k is 0, Z represents a group of formula III wherein n is 0, m is 1, and the symbols R^8 preferably represent hydrogen atoms, A, Q and p being as

- 21 -

hereinbefore defined, are prepared by the reaction of a compound of the general formula:-



wherein A, Q and R¹⁴ are as hereinbefore defined with a compound of the general formula:-



wherein p and R⁸ are as hereinbefore defined, preferably in the presence of a catalyst such as pyridinium 4-toluenesulphonate, preferably at reflux and preferably in a solvent such as toluene.

As yet another example, compounds of general formula I wherein k is 0, Z represents a 5-amino-1,2,4-triazol-3-ylamino group, A and Q being as hereinbefore defined, are prepared by the reaction of compounds of formula I wherein k is 0 and Z represents a group of the formula -NH-C(SR³)=N-CN, A, Q and R³ being as hereinbefore defined, with hydrazine, preferably in a solvent such as ethanol or ethoxyethanol, and preferably under reflux.

As yet another example, some compounds of general formula I are prepared by the reduction of other compounds of general formula I.

For example, (i) compounds of general formula I wherein k is 0, Q represents a group of formula -Q'CH₂-, wherein Q' represents a methylene group or alkylene chain containing from 2 to 4 carbon atoms,

- 22 -

optionally substituted with one or more alkyl groups containing from 1 to about 4 carbon atoms, and Z represents a group of formula $-NHR^2$, A and R^2 being as hereinbefore defined, are prepared by the reduction of compounds of general formula I wherein k is 0, Q represents a group of formula $-Q'-$, and Z represents a group of formula $-CONHR^5$, A, Q' and R^5 being as hereinbefore defined, R^2 and R^5 being identical, for example by reaction with a metal hydride such as lithium aluminium hydride, in an ether such as tetrahydrofuran.

(ii) compounds of general formula I wherein k is 0 and Z represents a group of formula VII wherein R^{11} and R^{12} represent hydrogen atoms, A, R^9 and R^{10} being as hereinbefore defined, are prepared by the reduction of compounds of general formula I wherein k is 0 and Z represents a group of formula V, A, R^9 and R^{10} being as hereinbefore defined, for example by reaction with a metal hydride such as di-isobutylaluminium hydride, in an ether such as tetrahydrofuran.

(iii) compounds of general formula I wherein k is 0 and Z represents a group of formula $-CH(OH)R^5$, A, Q and R^5 being as hereinbefore defined, are prepared by the reduction of compounds of general formula I wherein k is 0 and Z represents a group of formula $-COR^5$, A, Q and R^5 being as hereinbefore defined, for example by

- 23 -

reaction with a metal borohydride such as sodium borohydride in a solvent system such as aqueous ethanol.

As yet another example, some compounds of general formula I are prepared by the elimination of the elements of water from other compounds of general formula I.

For example, compounds of general formula I wherein k is 0 and Z represents a group of formula VI, A , Q and R^9 being as hereinbefore defined, are prepared by the elimination of the elements of water from compounds of general formula I wherein k is 0 and Z represents a group of formula V wherein R^{10} represents a hydroxy group, A , Q and R^9 being as hereinbefore defined, e.g. by reaction with trifluoroacetic acid.

As a further example, compounds of formula I wherein k is 0 and Z represents a group of the formula $-\text{CH}(\text{OH})\text{CH}_2(\text{CR}^9\text{R}^{10})_r\text{CH}_2\text{COR}^{16}$, wherein R^{16} represents a straight- or branched -chain alkylamino group containing from 1 to 4 carbon atoms, A , Q , R^9 , R^{10} and r being as hereinbefore defined, are prepared from compounds of formula I wherein k is 0 and Z represents a group of formula V wherein R^9 and R^{10} are as hereinbefore defined, A and Q being as hereinbefore defined, for example by reaction with the appropriate alkylamine of formula $R^{16}\text{NH}_2$, R^{16} being as hereinbefore defined,

- 24 -

preferably at an elevated temperature, e.g. at reflux, in a solvent such as ethanol.

As a still further example, compounds of formula I containing one or more lower alkoxy groups are prepared by the alkylation of compounds of formula I containing one or more hydroxy groups, for example by reaction with the appropriate lower alkanol, preferably in the presence of a catalyst such as boron trifluoride diethyl etherate.

As a further example, compounds of formula I wherein k is 0 and Z represents a group of the formula $-\text{COR}^5$, wherein R^5 is as hereinbefore defined, preferably an optionally substituted imidazole group, A and Q being as hereinbefore defined, are prepared by reaction of corresponding compounds of formula I wherein Z represents a morpholinocarbonyl group with the product of the reaction between lithium diisopropylamide (preferably complexed with mono-tetrahydrofuran) with a compound of formula $\text{R}^{5'}\text{H}$ wherein $\text{R}^{5'}$ represents a group within the definition of R^5 but wherein any free imino groups are temporarily protected, e.g. by dimethylaminomethyl groups.

As yet a further example, compounds of formula I wherein k represents 1 or 2, A, Q and Z being as hereinbefore defined, are prepared by the oxidation of compounds of formula I wherein A, Q and Z are as hereinbefore defined and p is less than in the desired

- 25 -

product.

The oxidation may be performed by using a conventional oxidant, such as hydrogen peroxide, sodium metaperiodate, a hypochlorite, an acyl nitrite, sodium perborate, peracids, such as percarboxylic acids (e.g. m-chloroperbenzoic acid), potassium permanganate or potassium hydrogen persulphate, or a ruthenium (VIII) compound, in an inert solvent, at or below room temperature.

Suitable solvents may include water, alcohols, water-alcohol mixtures, chlorinated hydrocarbons, such as dichloromethane, and organic acids.

As another example, compounds of formula I containing one or more carboxy groups are prepared by the hydrolysis by known methods of compounds of formula I containing one or more alkoxycarbonyl groups.

Compounds of general formula I wherein k is 1, the other symbols being as hereinbefore defined, may be obtained in a chirally pure form by separation of the enantiomers arising from a non-selective oxidation or by using known enantio-selective oxidising systems.

It is to be understood that, where in this specification reference is made to compounds of formula I, it is intended to refer also where the context so permits to their pharmaceutically acceptable salts. Such salts are prepared from the parent compounds of

- 26 -

formula I by the application or adaptation of known methods, or are produced by the processes described hereinafter. Parent compounds of formula I can be generated therefrom by the application or adaptation of known methods.

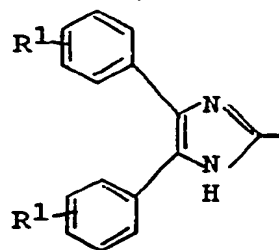
Preferred salts are acid addition salts such as the hydrochlorides or, where the compound of formula I contains an acidic hydrogen atom, for example when Z contains a carboxy group, salts formed with alkali metals, e.g. sodium and potassium, or alkaline earth metals, e.g. calcium and magnesium, or with ammonia or with pharmaceutically acceptable amines.

Compounds of formula I can be purified by the usual physical means, for example by crystallisation or chromatography.

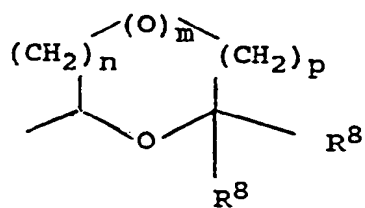
The following Examples illustrate the preparation of compounds according to the invention and the Reference Examples illustrate the preparation of intermediates.

In the presentation of the nuclear magnetic resonance ("NMR") spectra chemical shifts were expressed in parts per million relative to tetramethylsilane. Abbreviations have the following significances:- s = singlet, d = doublet, t = triplet, q = quartet, quin = quintet, m = multiplet, dd = doublet of doublets, dt = doublet of triplets, and br = broad signal.

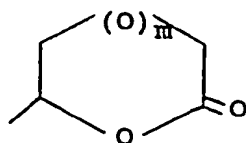
- 27 -



(II)

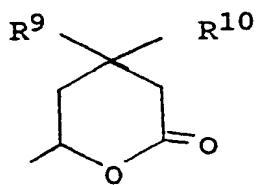


(III)

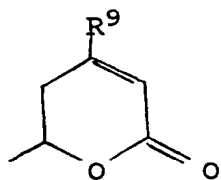


(IV)

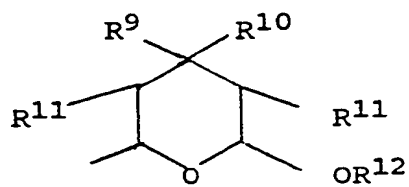
- 28 -



(V)



(VI)



(VII)

- 29 -

EXAMPLE 1

Compounds A, B, C, D, E, F, G,
H, I, J, K, L, M, N, O, P, and Q

A A stirred suspension of 4,5-diphenylimidazole-2-thiol (3.2g) and anhydrous potassium carbonate (1.8g) in anhydrous dimethylformamide (50ml) was stirred at room temperature for 15 minutes. It was then treated with 2-bromoethyl ethyl ether (2.4g) and the mixture was stirred at room temperature overnight. The mixture was filtered through silica gel and the bright yellow filtrate was evaporated to low bulk. The residue was shaken with ethyl acetate (100ml) and water (50ml). The layers were separated and the organic layer was washed with water (50ml), dried (magnesium sulphate) and evaporated.

The residue was subjected to flash chromatography eluting with a mixture of ethyl acetate and dichloromethane (1:3 v/v). Crystallisation from cyclohexane gave 2-(2-ethoxyethylthio)-4,5-diphenylimidazole (2.2g) in the form of a white crystalline solid, m.p. 91-92°C.

[Elemental analysis:- C,69.9;H,6.1;N,8.5;S,10.0%;

Calculated:- C,70.34;H,6.21;N,8.64;S,9.88%.

NMR (in CDCl₃):- 1.23 (3H,t,J = 8Hz), 3.18 (2H,t,J = 6Hz), 3.64 (2H,q,J = 8Hz), 3.83 (2H,t,J = 6Hz), 7.2-7.6 (10H,m)].

- 30 -

By proceeding in a similar manner, but replacing the 2-bromoethyl ethyl ether used as a starting material by the appropriate quantity of the corresponding halides, and optionally replacing the potassium carbonate by potassium t-butoxide, there were prepared the following compounds:-

B 2-[(dioxolan-2-yl)methylthio]-4,5-diphenyl-imidazole, m.p. 139-140°C.;

C 2-benzylthio-4,5-diphenylimidazole, m.p. 181-189°C.;

D 2-(3,5-dimethoxybenzylthio)-4,5-diphenylimidazole, m.p. 148.5-149.5°C.;

E 2-cyclohexylmethylthio-4,5-diphenylimidazole, m.p. 169-171°C.;

F [±]-2-[(tetrahydro-2H-pyran-6-yl)methylthio]-4,5-diphenylimidazole, m.p. 143-145°C.;

G [±]-2-[(tetrahydro-2H-pyran-6-yl)methylthio]-4(5)-(4-chlorophenyl)-5(4)-phenylimidazole, m.p. 127-129°C.;

H 2-[2-(1,3-dioxan-2-yl)ethylthio]-4,5-diphenylimidazole, m.p. 191-193°C.;

I 2-[3-(1,3-dioxan-2-yl)propylthio]-4,5-diphenylimidazole, m.p. 151°C.;

J 2-(2,2-diethoxyethylthio)-4,5-diphenylimidazole, m.p. 90-94°C.;

K 2-(2,2-dimethoxyethylthio)-4,5-diphenyl-

- 31 -

imidazole, m.p. 162-163°C.;

L 2-(3,3-diethoxypropylthio)-4,5-diphenyl-
imidazole, m.p. 247-249°C.;

M 2-(4-ethoxyhex-5-enylthio)-4,5-diphenyl-
imidazole, m.p. 91°C.;

N 2-[4-(2-hydroxyethyl)hept-6-enylthio]-4,5-
diphenylimidazole, in the form of a colourless gum;

O 2-(2-oxoprop-1-yl)thio-4,5-diphenylimidazole,
m.p. 145-147°C; and

P 2-(2-diethylaminoethylthio)-4,5-diphenyl-
imidazole, m.p. 90-92°C;

Q By again proceeding in a similar manner, but
replacing the 2-bromoethyl ethyl ether by
2-diisopropylaminoethyl chloride hydrochloride and the
potassium carbonate by potassium t-butoxide, and
treating a solution of the free base in ethanol with a
solution of hydrogen chloride in ethanol [prepared by
adding acetyl chloride (12ml) dropwise to cold ethanol
(100ml; 10°C) with stirring, maintaining the temperature
below 30°C] there was prepared 2-(2-diisopropylamino-
ethylthio)-4,5-diphenylimidazole, m.p. 183-185°C.

[Elemental analysis:- C, 60.8; H, 7.1; N, 9.; S, 7.3; Cl, 14.4%;
Calculated (C₂₃H₂₉N₃S:1.8HCl:0.5H₂O):- C, 60.8; H, 7.05;
N, 9.25; S, 7.06; Cl, 14.05%].

- 32 -

EXAMPLE 2Compound R

A stirred suspension of lithium hydroxide hydrate (4.2g) in ethanol (200ml) was treated, portionwise, with 4,5-diphenylimidazole-2-thiol. The mixture was stirred at ambient temperature for 30 minutes and then it was treated with propargyl chloride (7.45g), and stirring was continued for a further 3 hours. The reaction mixture was poured into water with stirring, and the resulting solid was filtered off, washed with water and dried. Recrystallisation from a mixture of petroleum ether (b.p.40-60°C) and dichloromethane, and then from toluene, gave 2-propargylthio-4,5-diphenylimidazole (16.07g) in the form of a white solid, m.p. 164-166°C.

[Elemental analysis:- C,74.2;H,4.73;N,9.6;S,10.9%;
Calculated:- C,74.45;H,4.86;N,9.65;S,11.04%].

EXAMPLE 3Compounds S, T and U

S A stirred suspension of 4,5-bis(2-chlorophenyl)-imidazole-2-thiol (2.0g) in anhydrous methanol (20ml) was treated with sodium methoxide (0.41g) and then stirred at room temperature for 5 minutes. The mixture was then treated with 2-bromomethyltetrahydro-2H-pyran (2.0g) and stirred at reflux for 2 hours. After cooling to room temperature the mixture was

- 33 -

poured into water (250ml) and the precipitate was filtered off. The product was dissolved in dichloromethane (100ml) and the solution was dried (magnesium sulphate) and evaporated. Trituration of the residue with diethyl ether gave a white solid, which was crystallised from methanol, to give [±]-4,5-bis(2-chlorophenyl)-2-[(tetrahydro-2H-pyran-2-yl)methylthio]imidazole (1.85g) in the form of a white powder, m.p. 162-4°C.

[Elemental analysis:- C,60.2;H,4.82;N,6.82;S,7.5%;
Calculated:- C,60.15;H,4.81;N,6.68;S,7.65.

NMR (in CDCl₃):- 1.5-2.0 (6H,m), 3.03 (1H,dd,J = 8Hz, 6Hz), 3.27 (1H,dd,J = 12Hz, 2Hz), 3.59 (1H,dt,J = 12Hz, 2Hz), 3.72 (1H,m), 4.21 (1H,dt,J = 10Hz, 2Hz)].

By proceeding in a similar manner, but replacing the 4,5-bis(2-chlorophenyl)imidazole-2-thiol with the appropriate quantity of the corresponding imidazole-2-thiol, there were prepared:-

T [±]-4(5)-(2-chlorophenyl)-5(4)-phenyl-2-[(tetrahydro-2H-pyran-2-yl)methylthio]imidazole,
m.p. 58-60°C.; and

U [±]-4(5)-(3-chlorophenyl)-5(4)-phenyl-2-[(tetrahydro-2H-pyran-2-yl)methylthio]imidazole, m.p. 113-5°C.

- 34 -

EXAMPLE 4Compounds V, W, X and Y

V A stirred suspension of 4,5-diphenylimidazole-2-thiol (4.2g) in anhydrous tetrahydrofuran (60ml) was treated with sodium hydride (80% dispersion in oil, 0.67g) under an argon atmosphere. After stirring at room temperature for 30 minutes the mixture was treated with [±]-2-iodomethyl-1,4-dioxane (4.2g). The resulting mixture was stirred at room temperature for 2 days, and then it was poured into water (500ml) and the product was filtered off and dried at 60°C.

Crystallisation from a mixture of isopropanol and diethyl ether gave [±]-2-[(1,4-dioxanyl)methylthio]-4,5-diphenylimidazole (1.14g), m.p. 144-147°C.

[Elemental analysis:- C, 68.0; H, 5.69; N, 8.2; S, 9.0%;

Calculated:- C, 68.18; H, 5.68; N, 7.95; S, 9.10%.

NMR (in CDCl₃):- 3.04 (1H, dd, J = 14Hz, 8Hz), 3.13

(1H, dd, J = 16Hz, 4Hz), 3.52 (1H, t, J = 10Hz), 3.6-4.0

(6H, m), 7.2-7.7 (10H, m).

By proceeding in a similar manner, but replacing the [±]-2-iodomethyl-1,4-dioxane by the appropriate quantity of the corresponding halide, and optionally carrying out the reaction in the presence of triethylamine at temperatures from ambient to the reflux temperature, there were prepared:-

W [±]-2-[(2,2-di(methoxymethyl)tetrahydro-2H-

- 35 -

pyran-6-yl)methylthio]-4,5-diphenylimidazole, m.p. 143-145°C.; and

X 2-(3-dimethylaminopropylthio)-4,5-diphenylimidazole, m.p. 138-140°C.

By again proceeding in a similar manner, but replacing the [±]-2-iodomethyl-1,4-dioxane by the appropriate quantity of 10-tosyloxy-2,5,8-trioxadecane and carrying out the reaction at 40-50°C for 150 minutes, there was prepared:-

Y 2-(3,6,9-trioxadecylthio)-4,5-diphenylimidazole, in the form of a yellow oil.

[Elemental analysis ($C_{22}H_{26}N_2O_3S \cdot 0.5CH_3OH$):-

C, 64.9; H, 6.59; N, 6.69; S, 7.8%;

Calculated:- C, 65.2; H, 6.58; N, 6.76; S, 7.7%].

EXAMPLE 5

Compounds Z and AA

Z A stirred suspension of 4,5-diphenylimidazole-2-thiol (2.9g) in anhydrous tetrahydrofuran (40ml) was treated with sodium hydride (80% dispersion in oil, 0.36g) under an argon atmosphere. The mixture was stirred at room temperature for 30 minutes and then it was treated with [±]-2,2-di(acetoxymethyl)-6-iodomethyltetrahydro-2H-pyran (4.9g). The resulting mixture was stirred at room temperature for 24 hours, poured into water (500ml), and the product was extracted into diethyl ether (100ml). The ethereal

- 36 -

solution was washed with water (50ml), dried (magnesium sulphate), and evaporated. The brown gummy residue was subjected to flash chromatography (eluting with a mixture of methanol and dichloromethane; 1:9 v/v) to give crude $[\pm]$ -2-[2,2-di(acetoxymethyl)tetrahydro-2H-pyran-6-ylmethylthio]-4,5-diphenylimidazole (4.8g).

A mixture of this product and potassium hydroxide (1.68g) in ethanol (25ml) and water (5ml) was stirred at room temperature for 75 minutes. The mixture was then evaporated to low bulk, diluted with water (40ml) and extracted with ethyl acetate (100ml, then 2x50ml). The resulting organic solution was dried (magnesium sulphate) and evaporated and the residue was crystallised from a mixture of methanol and ethyl acetate, to give $[\pm]$ -2-[2,2-di(hydroxymethyl)-tetrahydro-2H-pyran-6-ylmethylthio]-4,5-diphenylimidazole (1.54g), m.p. 176-178°C.

[Elemental analysis:- C, 67.1; H, 6.43; N, 6.7; S, 7.9%,

Calculated:- C, 67.32; H, 6.34; N, 6.83; S, 7.80%.

NMR (in a mixture of CDCl_3 and D_2O):- 1.2-1.8 (6H, m), 2.79 (1H, dd, $J = 10\text{Hz}, 12\text{Hz}$), 3.07 (1H, dd, $J = 12\text{Hz}, 2\text{Hz}$), 3.49 (2H, m), 3.69 (1H, d, $J = 10\text{Hz}$), 3.81 (1H, dt, $J = 10\text{Hz}, 2\text{Hz}$), 4.14 (1H, d, $J = 10\text{Hz}$), 7.2-7.6 (10H, m)].

AA A solution of $[\pm]$ -2-[2,2-di(hydroxymethyl)-tetrahydro-2H-pyran-6-ylmethylthio]-4,5-diphenyl-

- 37 -

imidazole (1.2g) in pyridine (5ml) was treated with acetic anhydride (0.92g) and the mixture was stirred at room temperature overnight. The mixture was treated with a further quantity of acetic anhydride (0.92g) in pyridine (5ml), followed, after one hour, by methanol (20ml). Evaporation of the mixture gave a colourless gum. The residue was treated with a mixture of water (20ml) and methanol (20ml) and it was evaporated again. This procedure was repeated three times, and then the residue was dissolved in ethyl acetate (25ml). This solution was dried (magnesium sulphate) and evaporated to give a pale yellow glass. This was triturated with a mixture diethyl ether and pentane to give [\pm]-2-[2,2-di(acetoxymethyl)tetrahydro-2H-pyran-6-ylmethylthio]-4,5-diphenylimidazole (1.0g) in the form of a stable meringue, m.p. 50-56°C.

[Elemental analysis:- C, 65.7; H, 6.25; N, 5.80; S, 6.4%;

Calculated:- C, 65.59; H, 6.07; N, 5.67; S, 6.48%.

NMR (in CDCl_3):- 1.3-1.8 (6H, m), 1.82 (3H, s), 2.07 (3H, s), 2.93 (1H, dd, $J = 16\text{Hz}, 8\text{Hz}$), 3.05 (1H, dd, $J = 10\text{Hz}, 2\text{Hz}$), 3.95 (2H, m), 4.02 (1H, d, $J = 12\text{Hz}$), 4.11 (1H, d, $J = 12\text{Hz}$), 4.85 (1H, d, $J = 12\text{Hz}$), 7.2-7.6 (10H, m)].

- 38 -

EXAMPLE 6Compounds AB and AC

AB A mixture of 4,5-diphenylimidazole-2-thiol (5.0g) and 2-bromoethanol (2.5g) in ethanol (150ml) was stirred at reflux for 4 hours. The mixture was filtered hot, cooled to 5°C., neutralised by treatment with sodium hydroxide solution (2M) and poured into iced water (1500ml). The resulting cream solid (4.8g) was filtered off and subjected to flash chromatography (eluting with a mixture of dichloromethane and methanol (19:1 v/v) followed by crystallisation from ethanol, to give 2-(2-hydroxyethylthio)-4,5-diphenylimidazole (0.7g), in the form of a white crystalline solid, m.p. 168-70°C.

[Elemental analysis:- C,68.7;H,5.5;N,9.4;S,10.6%;

Calculated:- C,68.9;H,5.45;N,9.45;S,10.81%.

NMR (in CD₃SOCD₃):- 3.20 (2H,t,J = 8Hz), 3.68 (2H,t,J = 8Hz), 7.2-7.5 (10H,m)].

AC By proceeding in a similar manner, but replacing the 2-bromoethanol by bromoethane, there was prepared:- 2-ethylthio-4,5-diphenylimidazole, m.p. 190°C.

EXAMPLE 7Compound AD

A mixture of 2-(2,2-diethoxyethylthio)-4,5-diphenylimidazole (10.0g), pyridinium 4-toluene-

- 39 -

sulphonate, polymer-bound (1.6g; approximately 6mmole of active component), and 1,3-propanediol (10.0g) in toluene (500ml) was stirred at reflux under a Dean and Stark water trap for 24 hours. At periodic intervals of about one hour the fluid collected in the water trap was run off and replaced in the reaction flask by fresh toluene. After cooling to room temperature, the mixture was washed with water (3x250ml), dried (magnesium sulphate) and evaporated. The resulting dark orange oil was subjected to flash chromatography (eluting with mixtures of ethyl acetate and dichloromethane; 1:9-4:6 v/v) and crystallised from ethyl acetate, to give 2-[(1,3-dioxan-2-yl)methylthio]-4,5-diphenylimidazole, (2.3g) m.p. 153-155°C.

[Elemental analysis:- C, 68.3; H, 5.75; N, 7.9; S, 9.1%;

Calculated:- C, 68.15; H, 5.72; N, 7.95; S, 9.10%.

NMR (in CDCl₃):- 1.38 (1H, m), 2.10 (1H, m) 3.11 (2H, d, J = 6Hz), 3.87 (2H, dt, J = 10Hz, 2Hz), 4.16 (2H, dd, J = 10Hz, 6Hz), 4.89 (1H, t, J = 6Hz), 7.2 7.5 (10H, m)].

EXAMPLE 8

Compounds AE, AG and AJ

AE A stirred solution of 2-(3-aminopropylthio)-4,5-diphenylimidazole (3.36g) in ethanol (150ml) at the ambient temperature was treated with S,S'-dimethyl-N-

- 40 -

cyanodithioiminocarbonate (1.76g), and stirred for one hour. The resulting solid was filtered off, washed with diethyl ether and dried, to give 3-cyano-2-methyl-1-[3-(4,5-diphenylimidazol-2-ylthio)propyl]isothiourea (3.15g) in the form of a colourless solid, m.p. 225-227°C.

[Elemental analysis:- C, 61.8; H, 5.3; N, 17.1; S, 15.6%;
calculated:- C, 61.92; H, 5.16; N, 17.20; S, 15.72%.

NMR (in a mixture of CD_3SOCD_3 and D_2O):- 1.94 (2H, quin, $J = 7\text{Hz}$), 2.53 (3H, s), 3.13 (2H, t, $J = 7\text{Hz}$), 3.44 (2H, t, $J = 7\text{Hz}$), 7.1-7.5 (10H, m)].

AG By proceeding in a similar manner, but replacing the 2-(3-aminopropylthio)-4,5-diphenylimidazole with the appropriate quantity of 2-(4-aminobutylthio)-4,5-diphenylimidazole, stirring for a total of 5 hours and, after evaporation of the reaction mixture, subjecting the residue to mpic (using a mixture of dichloromethane and methanol; 19:1 v/v) as eluent, there was prepared

3-cyano-2-methyl-1-[4-(4,5-diphenylimidazol-2-ylthio)-butyl]isothiourea (4.4g) in the form of a colourless solid, m.p. 103-105°C. (from isopropanol).

[Elemental analysis:- C, 62.5; H, 5.46; N, 16.5; S, 15.3%;
Calculated:- C, 62.68; H, 5.50; N, 16.61; S, 15.21%.

- 41 -

NMR (in a mixture of CD_3SOCD_3 and D_2O):- 1.67 (4H,m), 2.54 (3H,s), 3.13 (2H,t,J= 7Hz), 3.3-3.36 (2H,m), 7.2-7.47 (10H,m)].

AJ By again proceeding in a similar manner, but replacing the 2-(3-aminopropylthio)-4,5-diphenylimidazole with 2-(2-aminoethylthio)-4,5-diphenylimidazole, there was prepared 3-cyano-2-methyl-1-[2-(4,5-diphenylimidazol-2-ylthio)-ethyl]isothiourea (3.02g) in the form of a colourless solid, m.p. 215-217°C. (from ethanol). [Elemental analysis:- C,61.2;H,4.96;N,18.1;S,16.2%; Calculated:- C,61.04;H,4.87;N,17.80;S,16.30%.NMR (in a mixture of CD_3SOCD_3 and D_2O):- 2.38 (3H,s), 3.35 (2H,t,J= 7Hz), 3.74 (2H,t,J = 7Hz), 7.1-7.55 (10H,m)].

EXAMPLE 9

Compound AF

AF A suspension of 3-cyano-2-methyl-1-[2-(4,5-diphenylimidazol-2-ylthio)ethyl]isothiourea (1.6g) in ethanol (100ml) was treated with hydrazine hydrate (0.6ml). The mixture was heated under reflux for 2 hours, and the resulting solution was evaporated. The residue was dissolved in ethanol (250ml) and was then treated with a solution of acetyl chloride (5ml) in ethanol (20ml) with ice cooling. After stirring for 10 minutes, the solution was evaporated and the residue was dissolved in methanol (20ml). The

- 42 -

solution was treated with diethyl ether (60ml) and left to stand for 20 hours. The resulting solid was filtered off and dried, to give 2-[2-(5-amino-1,2,4-triazol-3-ylamino)ethylthio]-4,5-diphenylimidazole dihydrochloride (1.03g) in the form of a colourless solid, m.p. 223-226°C.

[Elemental analysis:- C,49.2;H,4.5;Cl,15.1;N,21.3;S,7.1;H₂O,3.2%;

Calculated (for C₁₉H₁₉N₇S:2HCl:H₂O):-

C,48.72;H,4.91;Cl,15.17;N,20.94;S,6.84%.

NMR (in D₂O):- 3.46-3.66 (4H,m), 7.36-7.54 (10H,m).

Example 10

Compounds AI and AH

AI A suspension of 3-cyano-2-methyl-1-[3-(4,5-diphenylimidazol-2-ylthio)propyl]isothiourea (2.2g) in ethoxyethanol (200ml) was treated with hydrazine hydrate (3.14ml). The mixture was heated under reflux for 6 hours, and the resulting solution was evaporated. The residue was triturated with hot acetonitrile (100ml), and the resulting solid was collected and dried, giving 2-[3-(5-amino-1,2,4-triazol-3-ylamino)propylthio]-4,5-diphenylimidazole (1.45g) in the form of a colourless solid, m.p. 225-227°C.

[Elemental analysis:- C,61.6;H,5.5;N,24.6;S,8.3%;

Calculated:- C,61.36;H,5.41;N,25.04;S,8.19%.

- 43 -

NMR (in a mixture of CD_3SOCD_3 and D_2O):- 1.87 (2H,quin,J= 7Hz), 3.1-3.17 (4H,m), 7.16-7.50 (10H,m)].

AH By proceeding in a similar manner, but substituting ethanol for the ethoxyethanol and 3-cyano-2-methyl-1-[4-(4,5-diphenylimidazol-2-ylthio)butyl]isothiourea for the 3-cyano-2-methyl-1-[3-(4,5-diphenylimidazol-2-ylthio)propyl]-isothiourea, there was prepared:-
2-[4-(5-amino-1,2,4-triazol-3-ylamino)butylthio]-4,5-diphenylimidazole in the form of a colourless solid, m.p. 214-216°C. (from isopropanol).

[Elemental analysis:- C,62.0;H,5.7;N,24.0;S,8.2%;
Calculated:- C,62.2;H,5.72;N,24.18;S,7.91%.

NMR (in a mixture of CD_3SOCD_3 and D_2O):- 1.57-1.74 (4H,m), 3.03 (2H,t,J = 7Hz), 3.13 (2H,t,J = 7Hz), 7.17-7.48 (10H,m)].

EXAMPLE 11

Compound AM

A suspension of 2-(3-aminopropylthio)-4,5-diphenylimidazole (1.55g; prepared as described in Reference Example 1) in acetic anhydride (10ml) was heated at 100°C for 3 minutes and then it was allowed to cool to the ambient temperature. The solution was then poured into water (50ml) and the mixture was allowed to stand for 90 minutes. The solution was treated with aqueous sodium hydroxide solution (2N) until it was

- 44 -

alkaline, and the mixture was then extracted with dichloromethane (2x30ml). The combined extracts were dried (MgSO₄) and evaporated, to give a colourless solid, which was recrystallised from acetonitrile, to give 2-(3-acetamidopropylthio)-4,5-diphenylimidazole (1.08g) in the form of a colourless solid, m.p. 180-181°C. [Elemental analysis:- C,68.7;H,6.1;N,12.1;S,8.9%; Calculated:- C,68.35;H,6.02;N,11.96;S,9.12%. NMR (in CDCl₃) 1.88 (2H,quin,J = 7Hz), 3.18 (2H,t,J = 7Hz), 3.44 (2H,q,J = 7Hz), 7.2-7.58 (10H,m), 7.65 (1H,br.t,J = 7Hz)].

Example 12

Compounds AO, AK, AN and AP

AO A stirred suspension of 4,5-diphenylimidazole-2-thiol (3.28g) in dry tetrahydrofuran (100ml) was treated with a dispersion of sodium hydride on oil (0.6g; 60%) at ambient temperature. After stirring at ambient temperature for 20 minutes. The solution was treated with 4-chloro-N-(4,6-dimethylpyrid-2-yl)butanamide (4.2g), followed by triethylamine (5ml). The resulting mixture was heated at reflux for 20 hours and then diluted with water (180ml) and diethyl ether (80ml). The organic layer was separated and extracted with dilute hydrochloric acid (100ml;1N). The acidic aqueous phase was then separated, made alkaline by treatment with aqueous sodium hydroxide solution (1N)

- 45 -

and then extracted with diethyl ether (2x150ml). The combined extracts were dried (MgSO₄) and evaporated, to give a solid residue, which was recrystallised from acetonitrile, to give N-(4,6-dimethylpyrid-2-yl)-4-(4,5-diphenylimidazol-2-ylthio)butanamide (2.5g) in the form of a colourless solid, m.p. 186-188°C.

[Elemental analysis:- C, 70.4; H, 5.81; N, 12.6; S, 6.6%;

Calculated:- C, 70.56; H, 5.92; N, 12.66; S, 7.25%.

NMR (in CDCl₃):- 2.17 (2H, quin, J = 7Hz), 2.3 (3H, s), 2.35 (3H, s), 2.62 (2H, t, J = 7Hz), 3.1 (2H, t, J = 7Hz), 6.74 (1H, s), 7.23-7.57 (10H, m), 7.79 (1H, s), 8.22 (1H, br. s)].

AK By proceeding in a similar manner, but substituting the appropriate quantity of 4-chloro-N-(4-methylpyrid-2-yl)butanamide for the 4-chloro-N-(4,6-dimethylpyrid-2-yl)butanamide, there was prepared:-

N-(4-methylpyrid-2-yl)-4-(4,5-diphenylimidazol-2-ylthio)butanamide in the form of a colourless solid, m.p. 147-149°C.

[Elemental analysis:- C, 69.5; H, 5.7; N, 13.0; S, 7.7%;

Calculated:- C, 70.09; H, 5.61; N, 13.08; S, 7.48%.

NMR (in CDCl₃):- 2.19 (2H, quin, J = 7Hz), 2.35 (3H, s), 2.65 (2H, t, J = 7Hz), 3.14 (2H, t, J = 7Hz), 6.86 (1H, d, J = 6Hz), 7.2-7.63 (10H, m), 7.97 (1H, s), 8.02 (1H, d, J = 6Hz), 8.49 (1H, br. s)].

- 46 -

AN By proceeding in a similar manner, but substituting the appropriate quantity of N-(4-chlorobutanoyl)-2,6-dimethylmorpholine for the 4-chloro-N-(4,6-dimethylpyrid-2-yl)butanamide, there was prepared:-

2,6-dimethyl-N-[4-(4,5-diphenylimidazol-2-ylthio)-butan-1-oyl]morpholine (4.7g) in the form of a colourless solid, m.p. 147-149°C.

[Elemental analysis:- C,68.6;H,6.79;N,9.7;S,7.4%;

Calculated:- C,68.93;H,6.71;N,9.65;S,7.36%.

AP By proceeding in a similar manner, but substituting the appropriate quantity of 4-chloro-N-(pyrid-2-yl)butanamide for the 4-chloro-N-(4,6-dimethylpyrid-2-yl)butanamide, there was prepared:- N-(pyrid-2-yl)-4-(4,5-diphenylimidazol-2-ylthio)butanamide (0.8g) in the form of a colourless solid, m.p. 167-169°C.

[Elemental analysis:- C,68.8;H,5.19;N,13.2%;

Calculated:- C,69.54;H,5.35;N,13.52%].

Example 13

Compound AL

A stirred suspension of lithium aluminium hydride (0.42g) in dry tetrahydrofuran was treated portionwise with N-(4,6-dimethylpyrid-2-yl)-4-(4,5-diphenylimidazol-2ylthio)butanamide (2.44g) at -10°C under an argon atmosphere. The mixture was then

- 47 -

stirred at the ambient temperature for 2 hours. It was then treated with water (0.7ml), followed by aqueous sodium hydroxide solution (2.1ml;15%) and then water (2.1ml). After stirring for 10 minutes, the mixture was filtered and the filtrate was evaporated, to give a colourless solid. This solid was subjected to flash chromatography on silica gel, using a mixture of dichloromethane and methanol (39:1 v/v) as eluent, to give 4,6-dimethyl-2-[4-(4,5-diphenyl-imidazol-2-ylthio)butylamino]pyridine (1.64g), in the form of a colourless solid, m.p. 166-168°C. [Elemental analysis:- C,72.7;H,6.6;N,12.9;S,7.5%; Calculated:- C,72.9;H,6.54;N,13.08;S,7.48%. NMR (in CDCl₃):- 1.73-1.84 (4H,m), 2.18 (3H,s), 2.2 (3H,s), 3.1 (2H,t,J = 7Hz), 3.22 (2H,q,J = 7Hz), 4.63 (1H,br.t,J = 7Hz), 6.0 (1H,s), 6.27 (1H,s), 7.2-7.63 (10H,m).

EXAMPLE 14

Compounds AQ to BF

AQ Sodium methoxide (2.16g) was added to a stirred suspension of 4,5-diphenylimidazole-2-thiol (10.0g) in anhydrous methanol (250ml). After stirring at room temperature for 30 minutes methyl 4,5-epoxypentanoate (7.7g) was added and the mixture was stirred at room temperature overnight. Evaporation gave a light yellow residue, which was shaken with ethyl acetate

- 48 -

(250ml) and water (250ml). The layers were separated and the organic layer dried (magnesium sulphate) and evaporated. The residue was boiled with methanol (100ml) for 15 minutes and then allowed to cool to room temperature. The white insoluble solid was collected by filtration and washed with a little fresh methanol. The solution was treated with fresh methanol (100ml) and 1M sodium hydroxide solution (50ml). After standing at room temperature for 2 hours the clear solution was evaporated to dryness and shaken with ethyl acetate (200ml) and 2M acetic acid solution (150ml). The layers were separated and the organic layer dried (magnesium sulphate) and evaporated. The oily residue was dissolved in dichloromethane (300ml) and treated with trifluoroacetic acid (10ml). After standing at room temperature for 2 hours the solution was washed with 5% sodium hydrogen carbonate solution (5x150ml), dried (magnesium sulphate) and evaporated. The resulting white foam was subjected to flash chromatography (ethyl acetate-dichloromethane mixture, 1:1 v/v). Crystallisation from ethyl acetate/hexane gave (5R,5S)-4,5-diphenyl-2-[(2-oxotetrahydrofuran-5-yl)methylthio]imidazole (2.0g) in the form of a dense white solid, m.p. 118-120°C.

[Elemental analysis:- C,68.7;H,5.21;N,7.9;S,9.1%;
Calculated:- C,68.55;H,5.18;N,7.99;S,9.15%.

- 49 -

NMR (in CDCl_3):- 2.10 (1H,m), 2.3-2.7 (3H,m) 3.32 (1H,m), 4.83 (1H,m), 7.2-7.5 (10H,m)].

AR By proceeding in a similar manner, but substituting 4,5-bis(3-chlorophenyl)imidazole-2-thiol for the 4,5-diphenylimidazole-2-thiol, and t-butyl 5,6-epoxy-3-hydroxy-3-methylhexanoate for the methyl 4,5-epoxypentanoate, there was prepared:-
(4R,4S) (6R,6S)-6-[(4,5-bis(3-chlorophenyl)imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one in the form of a white solid, m.p. 178°C.
[Elemental analysis:- C,57.1;H,4.32;Cl,15.1;N,5.88;S,6.73%; Calculated:- C,57.02;H,4.35;Cl,15.3;N,6.05;S,6.92%. NMR (in CDCl_3):- 1.35(3H,s), 1.66-1.8(1H,m), 2.14-2.22(1H,m), 2.4-2.78(2H,m), 3.4(2H,d,J = 4Hz), 4.41 (1H.s),4.9-5.1(1H,m)].

By again proceeding in a similar manner, and replacing the 4,5-bis(3-chlorophenyl)imidazole-2-thiol with the appropriate quantity of the corresponding imidazole-2-thiol, there were also prepared:-

AS (4R,4S) (6R,6S)-6-[(4,5-Bis(4-chlorophenyl)-imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one, m.p. 190-1°C.

[Elemental analysis:- C,56.8;H,4.3;Cl,15.7;N,5.9;S,6.82%; Calculated:- C,57.02;H,4.35;Cl,15.3;N,6.05;S,6.92%].

AT (4R,4S) (6R,6S)-6-[(4,5-Bis(2-chlorophenyl)-imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydro-

- 50 -

pyran-2-one, m.p. 100°C.

[Elemental analysis:- C, 56.8; H, 4.36; Cl, 15.2; N, 6.04; S, 7.2%;

Calculated:- C, 57.02; H, 4.35; Cl, 15.3; N, 6.05; S, 6.92%].

AU (4R,4S) (6R,6S)-6-[(4,5-Bis{4-fluorophenyl}-
imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetra-
hydropyran-2-one, m.p. 174-178°C.

[Elemental analysis:- C, 61.7; H, 4.8; F, 8.9; N, 6.5; S, 7.4%;

Calculated:- C, 61.38; H, 4.68; F, 8.83; N, 6.51; S, 7.45%].

AV (4R,4S) (6R,6S)-6-[(4,5-Bis{4-trifluoromethyl-
phenyl}imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyl-
tetrahydropyran-2-one, m.p. 205°C.

[Elemental analysis:- C, 54.6; H, 3.99; N, 5.28%;

Calculated:- C, 54.3; H, 3.80; N, 5.28%].

AW (4R,4S) (6R,6S)-4-Hydroxy-6-[(4,5-bis{3-methyl-
phenyl}imidazol-2-yl)thiomethyl]-4-methyltetra-
hydropyran-2-one, m.p. 86-88°C.

[Elemental analysis:- C, 67.90; H, 6.40; N, 6.50; S, 7.30%;

Calculated:- C, 68.22; H, 6.20; N, 6.63; S, 7.59%].

AX (4R,4S) (6R,6S)-4-Hydroxy-6-[(4,5-bis{4-methyl-
phenyl}imidazol-2-yl)thiomethyl]-4-methyltetrahydro-
pyran-2-one, m.p. 205-7°C.

[Elemental analysis:- C, 68.1; H, 6.09; N, 6.42%;

Calculated:- C, 68.22; H, 6.20; N, 6.63%].

AY (4R,4S) (6R,6S)-4-Hydroxy-6-[(4,5-bis{4-
isopropylphenyl}imidazol-2-yl)thiomethyl]-4-
methyltetrahydropyran-2-one, m.p. 89-91°C.

- 51 -

[Elemental analysis:- C, 69.8; H, 7.2; N, 5.9; S, 6.36%;

Calculated:- C, 70.26; H, 7.16; N, 5.85; S, 6.69%.

AZ (4R,4S) (6R,6S) -6-[(4,5-Bis{4-tertbutylphenyl}-imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one, m.p. 134-51°C.

[Elemental analysis ($C_{30}H_{38}N_2O_3S:1/4H_2O$):-

C, 70.5; H, 7.7; N, 5.3; S, 6.33; H_2O , 1.2%;

Calculated:- C, 70.48; H, 7.59; N, 5.48; S, 6.2; H_2O , 0.81%].

BA (4R,4S) (6R,6S) -4-Hydroxy-6-[(4,5-bis{2-methoxyphenyl}imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one, m.p. 108-10°C.

[Elemental analysis ($C_{24}H_{26}N_2O_5S:C_4H_8O_2$):-

C, 61.8; H, 5.9; N, 5.5; S, 6.37%;

Calculated:- C, 61.99; H, 6.27; N, 5.17; S, 5.90%].

BB (4R,4S) (6R,6S) -4-Hydroxy-6-[(4,5-bis{3-methoxyphenyl}imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one, m.p. 148°C.

[Elemental analysis ($C_{24}H_{26}N_2O_5S:0.45C_4H_8O_2$):-

C, 62.2; H, 5.74; N, 5.79%;

Calculated:- C, 62.7; H, 6.04; N, 5.67; S, 6.94%].

BC & BD

BC By proceeding in a similar manner, and replacing the 4,5-bis(3-chlorophenyl)imidazole-2-thiol by 4,5-diphenylimidazole-2-thiol in the reaction with t-butyl-5,6-epoxy-3-hydroxy-3-methylhexanoate, there was obtained a product in the form of a mixture of 2

- 52 -

racemates. This mixture was triturated with diethyl ether, and the insoluble material recrystallised from a mixture of ethyl acetate and methanol, to give 6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one, m.p. 201-202.5°C.

[Elemental analysis:- C, 67.10; H, 5.70; N, 7.10; S, 8.00%;
Calculated:- C, 66.98; H, 5.62; N, 7.10; S, 8.13%.

NMR (in CD_3SOCD_3):- 1.1(3H,s), 1.64-2.06(2H,m),
2.3-2.6(2H,m), 3.4-3.5(2H,m), 4.76-4.92(1H,m),
5.06(1H,m)].

BD The washings from the trituration were concentrated, to give a white solid, which was recrystallised from a mixture of ethyl acetate and methanol, to give 6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one, m.p. 203.5-205°C.

[Elemental analysis:- C, 66.60; H, 5.56; N, 6.94; S, 8.10%;
Calculated:- C, 66.98; H, 5.62; N, 7.10; S, 8.13%.

NMR (in CD_3SOCD_3):- 1.24(3H,s), 1.7-2.3(2H,m),
2.3-2.7(2H,m), 3.4-3.5(2H,m), 4.54-4.7(1H,m),
5.04(1H,s), 7.15-7.6(10H,m)].

BE & BF By proceeding in a similar manner to that described for Compounds BC and BD, but replacing the 4,5-diphenylimidazole-2-thiol by the appropriate quantity of 4,5-bis-(4-methoxyphenyl)imidazole-2-thiol, there were obtained:-

- 53 -

4-hydroxy-6-[(4,5-bis(4-methoxyphenyl)imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one, m.p. 214-215° and 90-115°C. [Elemental analyses:- Compound BE:- C, 63.3; H, 5.82; N, 6.11; S, 7.1%; Compound BF:- C, 63.8; H, 5.94; N, 5.94; S, 6.9%; Calculated:- C, 63.44; H, 5.73; N, 6.17; S, 7.05%].

EXAMPLE 15

Compounds BG TO BL

BG A suspension of (4R,4S)(6R,6S)-4-hydroxy-6-[(4,5-bis(4-methylphenyl)imidazol-2-yl)thiomethyl]-4-methyltetrahydropyran-2-one (4.7g.) in dichloromethane (250ml) was treated dropwise with trifluoroacetic anhydride (6.3g) with ice-cooling, and left to stand at room temperature for 24 hours. The resulting solution was washed with saturated aqueous sodium bicarbonate solution, dried over magnesium sulphate, and evaporated, to give a gum. This gum was dissolved in toluene (200ml), and treated with 1,8-diazabicyclo[5.4.0]undec-2-ene (4.5g), and left to stand at room temperature for 24 hours. The solution was then washed with water, dried over magnesium sulphate, and evaporated to give a white foam. This was recrystallised from a mixture of ethyl acetate and methanol, to give (6R,6S)-6-[(4,5-bis(4-methylphenyl)imidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one, (2.1g), m.p. 191°C.

- 54 -

[Elemental analysis:- C,71.2;H,6.12;N,6.85;S, 7.8 %;

Calculated:- C,71.26;H,5.98;N,6.93;S,7.93%.

NMR (in CDCl₃):- 1.96(3H,s), 2.3(6H,s), 2.54(2H,d,J = 8Hz), 3.48(2H,d,J = 6Hz), 4.6-4.8(1H,m), 5.8(1H,d), 7.0-7.2(8H,m).

By proceeding in a similar manner, but replacing compound AX with the appropriate quantity of the corresponding compound from compounds AR to BF, there were also prepared:-

BH (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)-thiomethyl]-5,6-dihydro-4-methylpyran-2-one, m.p. 70-71°C.

[Elemental analysis:- C, 69.7;H,5.69;N,7.3;S,8.6%;

Calculated:- C,70.19;H,5.36;N,7.44;S,8.52%].

BI (6R,6S)-6-[(4,5-Bis{4-chlorophenyl}imidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one, m.p. 175-176°C. [Elemental analysis:-

C,59.1;H,4.04;N,6.3;S,7.3;Cl,15.8%;

Calculated:- C,59.33;H,4.07;N,6.29;S,7.20;Cl,15.92%].

BJ (6R,6S)-6-[(4,5-bis{3-chlorophenyl}imidazol-2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one, m.p. 132-135°C.

[Elemental analysis:-

C,59.3;H,4.2;N,6.4;S,7.1;Cl,15.6%;

Calculated:- C,59.33;H,4.07;N,6.29;S,7.20;Cl,15.92%].

BK (6R,6S)-6-[(4,5-bis-{2-chlorophenyl}imidazol-

- 55 -

2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one, m.p..
126-127°C.

[Elemental analysis:- C,59.2;H,4.04;N,6.2;Cl,15.9%;
Calculated:- C,59.33;H,4.07;N,6.29;S,7.20;Cl,15.92%].

BL (6R,6S)-6-[(4,5-bis-{4-fluorophenyl}imidazol-
2-yl)thiomethyl]-5,6-dihydro-4-methylpyran-2-one, m.p..
123-126°C.

[Elemental analysis:- C,64.5;H,4.6;N,6.9;S,7.8;F,9.3%;
Calculated:- C,64.06;H,4.4;N,6.79;S,7.77;F,9.21%].

EXAMPLE 16

Compounds BM TO BQ

BM A mixture of 5-(iodomethyl)-2-furanone (2.06g),
4,5-bis-(4-methylphenyl)imidazole-2-thiol (2.29g), and
potassium carbonate (0.56g), in dry dimethylformamide
(40ml) was stirred at room temperature for 24 hours.
The dimethylformamide was removed by evaporation at
reduced pressure, and the residue was shaken with water
and dichloromethane, the organic layer separated, and
the aqueous layer extracted with more dichloromethane.
The combined organic solutions were dried over
magnesium sulphate and concentrated, to give a yellow
semi-solid. This was subjected to chromatography on
silica gel, eluting with a mixture of ethyl acetate and
dichloromethane, (3:7v/v), and the foam obtained was
recrystallised from diethyl ether to give
(5R,5S)-5-[(4,5-bis-{4-methylphenyl}imidazol-2-

- 56 -

yl)thiomethyl]tetrahydrofuran-2-one, (2.05g), m.p.
128-129°C.

[Elemental analysis:- C,69.7;H,5.83;N,7.3;S,8.6%;

Calculated:- C,69.81;H,5.86;N,7.40;S,8.47%.

NMR (in CDCl₃):- 1.96-2.7(4H,m), 2.36(6H,s),

3.3(2H,dd,J = 6Hz,2Hz), 4.72-4.9(1H,m),

6.96-7.5(8H,m)].

BN By proceeding in a similar manner, but replacing the 4,5-bis-(4-methylphenyl)imidazole-2-thiol by the appropriate quantity of 4,5-diphenylimidazole-2-thiol, and the 5-(iodomethyl)-2-furanone by the appropriate quantity of (6R,6S)-6-(iodomethyl)-3,4,5,6-tetrahydropyran-2-one, there was prepared:-
(6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-3,4,5,6-tetrahydropyran-2-one, with no sharp melting point.

[Elemental analysis:- C,69.00;H,5.52;N,7.7;S,8.70%;

Calculated:- C,69.20;H,5.53;N,7.69;S,8.80].

BO By again proceeding in a similar manner, but replacing the (6R,6S)-6-(iodomethyl)-3,4,5,6-tetrahydropyran-2-one by 4,4-dimethyl-6-iodomethyl-3,4,5,6-tetrahydropyran-2-one there was prepared:-
(6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4,4-dimethyl-3,4,5,6-tetrahydropyran-2-one, m.p.
130-131°C.

[Elemental analysis:- C,70.0;H,6.34;N,6.6;S,8.1%;

- 57 -

Calculated:- C,70.38;H,6.16;N,7.14;S,8.17%.

By again proceeding in a similar manner, but replacing the 5-(iodomethyl)-2-furanone by (4R,4S) (6R,6S)-4-hydroxy-6-iodomethylpyran-2-one, there was obtained, after chromatography:-

BP (4R,4S) (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-3,4,5,6-tetrahydropyran-2-one, m.p. 191-192°C.

[Elemental analysis:- C,66.2;H,5.26;N,7.3;S,8.2%;

Calculated:- C,66.29;H,5.30;N,7.36;S,8.43%] and

BQ (3R,3S) (5R,5S)-ethyl 6-[(4,5-diphenylimidazol-2-yl)thio]-3,5-dihydroxyhexanoate, m.p. 94-95°C.

[Elemental analysis:- C,64.4;H,6.02;N,6.48;S,7.5 %;

Calculated:- C,64.77;H,6.14;N,6.57;S,7.52%].

NMR (in CDCl₃):- 1.21(3H,t), 1.5-2.1(2H,m), 2.22-2.6(2H,m), 2.9-3.2(2H,m), 4.16(2H,q), 2.2-2.4(2H,m).

EXAMPLE 17

Compound BR

A mixture of 4,5-diphenylimidazole-2-thiol (3.5g) and anhydrous potassium carbonate (2.9g) in anhydrous dimethylformamide (60ml) was stirred at room temperature for 30 minutes. It was then treated with (2R,2S)-2-(iodomethyl)-6-oxo-1,4-dioxane (3.4g) and the resulting mixture stirred at room temperature for 3 days. The mixture was poured into water (600ml) and the product collected by filtration and dried at

- 58 -

60°C., to give a cream solid (2.6g). A portion (1.5g) of this solid was dissolved in dichloromethane (60ml) and treated with trifluoroacetic acid (0.48g). After 30 minutes the solution was diluted with fresh dichloromethane (100ml) and washed with 5% sodium hydrogen carbonate solution (75ml). The layers were separated and the organic fraction washed with water (50ml), dried (magnesium sulphate) and evaporated. Crystallisation from tetrahydrofuran/diethyl ether gave (6R,6S)-[(4,5-diphenylimidazol-2-yl)thiomethyl]-2-oxo-1,4-dioxane (0.5g) in the form of a white powder, m.p. 194-196°C.

[Elemental analysis:- C,64.8;H,4.91;N,7.7;S,8.8%;

Calculated:- C,65.57;H,4.92;N,7.65;S,8.74%;

NMR (CD_3SOCD_3):- 3.46 (2H,d,J = 6Hz), 3.76 (1H,dd,J = 12Hz, 6Hz), 4.05 (1H,dd,J = 12Hz, 4Hz), 4.32 (2H,dd,J = 16Hz, 4Hz), 4.87 (1H,m), 7.2-7.5 (10H,m)].

EXAMPLE 18

Compound BS

Sodium methoxide (0.34g) was added to a suspension of 4,5-bis-(4-chlorophenyl)imidazole-2-thiol (2.0g) in methanol (50ml), and the mixture was stirred at room temperature for one hour. t-Butyl 5,6-epoxy-3-hydroxy-3-methylhexanoate (1.98g), was added and the mixture was stirred at room temperature for 18 hours. It was then concentrated at reduced pressure and the

- 59 -

residue was shaken with ethyl acetate and water. The ethyl acetate layer was separated, dried over magnesium sulphate, and concentrated, to give a semi-solid. This was triturated with diethyl ether, to give a white solid, which was subjected to chromatography on silica gel eluting with a mixture of dichloromethane and ethyl acetate, to give a gum, which was recrystallised from cyclohexane to give t-butyl 6-[(4,5-bis-{4-chlorophenyl}imidazol-2-yl)thio]-3,5-dihydroxy-3-methylhexanoate in the form of one racemate, a white crystalline solid, m.p. 152-153°C. [Elemental analysis:- C, 58.3; H, 5.68; Cl, 13.3; N, 5.18; S, 5.94%; Calculated:- C, 58.1; H, 5.63; Cl, 13.19; N, 5.21; S, 5.97%. NMR (in CDCl₃):- 1.32(3H,s), 1.46(9H,s), 1.64(1H,dd,J = 12Hz, 4Hz), 1.9-2.1(1H,m), 2.3-2.7(2H,m), 2.98-3.3(2H,m), 4.3-4.5(1H,m), 4.8-6.4(2H,br.s), 7.1-7.6(8H,m).

EXAMPLE 19

Compound BT

6-[(4,5-Diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetrahydropyran-2-one (4.22g), was added to a solution of sodium hydroxide (1.0M; 10.66ml) and water (70ml), and warmed at 60°C for 10 minutes. Traces of solid were removed by filtration, and the filtrate was concentrated at reduced pressure to give a glass. This was dissolved in dimethylformamide (40ml),

- 60 -

and treated with ethyl iodide (2.15g), and the mixture was stirred at room temperature for 2 hours. It was then shaken with ethyl acetate and water, the organic layer was separated and washed with water, dried over magnesium sulphate, and concentrated, to give an oil. This was subjected to chromatography on silica gel, eluting with a mixture of dichloromethane and ethyl acetate (1:1v/v), to give (3R,3S)(5R,5S)-ethyl 6-[(4,5-diphenylimidazol-2-yl)thio]-3,5-dihydroxy-3-methylhexanoate (2.47g), in the form of a yellow solid with no sharp melting point.

[Elemental analysis:- C,64.9;H,6.4;N,6.2;S,7.1%;

Calculated:- C,64.46;H,6.54;N,6.54;S,7.48%.

NMR (in CDCl₃):- 1.24(3H,2dt), 1.6(1H,dd,J = 10Hz, 3Hz), 1.9-2.1(1H,m), 2.4-2.7(1H,m), 2.9-3.2(2H,m), 4.05-4.24 (3H,m), 4.38-4.58(1H,m), 7.1-7.5(10H,m)].

EXAMPLE 20

Compound BU

(6R,6S)-6-[(4,5-Diphenylimidazol-2-yl)thio-methyl]-4,4-dimethyl-3,4,5,6-tetrahydropyran-2-one (1.18g) was dissolved in 33% ethanolic methylamine (50ml), and heated at reflux for 2 hours. It was then concentrated to give a solid, which was recrystallised from ethanol to give (2R,2S)-2-[(2-hydroxy-4,4-dimethyl-5-methylaminocarbonylpent-1-yl)thio]-4,5-diphenylimidazole (0.53g), m.p. 190-191°C.

- 61 -

[Elemental analysis:- C, 68.3; H, 7.0; N, 9.9; S, 8.1%;

Calculated:- C, 68.05; H, 6.9; N, 9.92; S, 7.6%.

NMR (in CD_3SOCD_3) 0.98(3H,s), 1.0(3H,s), 1.5-1.7(2H,m),
1.98-2.24(2H,m), 2.5-2.7(4H,m), 3.18(2H,m),
3.9-4.05(1H,m), 5.5-5.7(1H,m), 7.2-7.9(10H,m)].

EXAMPLE 21

Compounds BV and BW

BV (6R,6S)-6-[(4,5-Diphenylimidazol-2-yl)thio-
methyl]-3,4,5,6-tetrahydropyran-2-one, (3.96g), in dry
tetrahydrofuran, (55ml), was treated at -78°C in an
argon atmosphere with di-isobutylaluminium hydride in
tetrahydrofuran (1.0M;55ml), and stirred at -78°C for 3
hours. It was then poured into a mixture of ice (250g),
water (100ml) and acetic acid (50ml), and extracted
with dichloromethane. The dichloromethane extracts were
combined, washed with water, and dried over magnesium
sulphate. Concentration gave a yellow oil, which was
subjected to chromatography on silica gel, eluting with
a mixture of dichloromethane and ethyl acetate
(3:1v/v), and the white solid obtained was
recrystallised from a mixture of ethyl acetate and
hexane to give (2R,2S)(6R,6S)-6-[(4,5-diphenyl-
imidazol-2-yl)thiomethyl]-2-hydroxy-3,4,5,6-tetra-
hydropyran (1.15g), m.p.. $172-173^\circ\text{C}$.

[Elemental analysis:- C, 68.7; H, 6.03; N, 7.6; S, 8.5%;

Calculated:- C, 68.82; H, 6.05; N, 7.64; S, 8.75%.

- 62 -

NMR (in a mixture of CDCl_3 and CD_3SOCD_3):-

1.2-2.1(6H,m), 2.9-3.3(2H,m), 3.6-3.8(1/4H,m),
4.1-4.3(3/4H,m), 4.7-4.8(1/4H,m), 5.34(3/4H,s),
5.78(3/4H,d,J = 3Hz), 6.46(1/4H,d,J = 6Hz),
7.1-7.8(10H,m)].

BW By proceeding in a similar manner, but replacing
(6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-
3,4,5,6-tetrahydropyran-2-one by 6-[(4,5-diphenyl-
imidazol-2-yl)thiomethyl]-4-hydroxy-4-methyltetra-
hydropyran-2-one there was prepared
(2R,2S)(4R,4S)(6R,6S)-6-[(4,5-diphenylimidazol-2-
yl)thiomethyl]-2,4-dihydroxy-4-methyltetrahydropyran,
m.p. 134-151°C.

[Elemental analysis:- C,66.8;H,6.11;N,7.2;S,8.1%;
Calculated:- C,66.64;H,6.10;N,7.07;S,8.09%].

EXAMPLE 22

Compounds BX & BY

(2R,2S)(4R,4S)(6R,6S)-6-[(4,5-diphenylimidazol-
2-yl)thiomethyl]-2,4-dihydroxy-4-methyltetrahydropyran
(1.9g), was dissolved in anhydrous methanol (150ml),
boron trifluoride diethyl etherate (3ml) was added, and
the solution was left to stand at room temperature for
64 hours. It was then added to excess sodium
bicarbonate solution, extracted with ethyl acetate, and
the organic extracts were washed with water, dried over
magnesium sulphate, and concentrated, to give a white

- 63 -

solid. This was subjected to chromatography on silica gel eluting with a mixture of ethyl acetate and cyclohexane (2:1v/v), to give compound BX, (2R,2S) (4R,4S) (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-2-methoxy-4-methyltetrahydropyran (0.61g), thought to be the 2-alpha-anomer, in the form of a white solid, m.p. 163-166°C.

[Elemental analysis:- C,67.1;H,6.41;N,6.61;S,7.6%;

Calculated:- C,67.29;H,6.38;N,6.83;S,7.81%.

NMR (in CD_3SOCD_3):- 1.16(3H,s), 1.1-1.4(2H,m), 1.5-1.7(2H,m), 3.3(3H,s), 3.2-3.4(2H,m), 3.9-4.1(1H,m), 4.48(1H,s), 4.58(1H,dd,J = 6Hz,2Hz); and

compound BY, (2R,2S) (4R,4S) (6R,6S)-6-[(4,5-diphenylimidazol-2-yl)thiomethyl]-4-hydroxy-2-methoxy-4-methyltetrahydropyran, thought to be the 2-beta-anomer, 0.51g, m.p. 46°C.

[Elemental analysis:- C,67.1;H,6.68;N,6.52;S,7.4%;

Calculated:- C,67.29;H,6.38;N,6.83;S,7.81%.

NMR (in CD_3SOCD_3)- 1.08(1H,s), 1.25-1.75(4H,m), 3.3(3H,m), 3.2-3.4(2H,m), 4.0(1H,s), 4.1-4.22(1H,m), 4.8(1H,m), 7.1-7.5(10H,m)].

EXAMPLE 23

Compound BZ

4,5-diphenylimidazole-2-thiol (12.99g) was dissolved in dry dimethylformamide (200ml), and then it was treated with potassium carbonate (5.44g) and methyl

- 64 -

6-deoxy-6-iodo- α -D-mannopyranoside (15.66g) and stirred at room temperature for 18 hours. The mixture was then filtered and concentrated at reduced pressure to give an orange oil, which was subjected to chromatography on silica gel, eluting with a mixture of ethyl acetate and hexane, (9:1v/v), to give a white solid which was triturated with cyclohexane to give (2S,3R,4R,5S,6S)-2-[(4,5-diphenylimidazol-2-yl)thiomethyl]-6-methoxy-3,4,5-trihydroxytetrahydropyran (7.0g), m.p. 120-122°C.

[Elemental analysis:- C,61.2;H,5.87;N,6.44;S,8.0%;

Calculated:- C,61.66;H,5.65;N,6.54;S,7.48%.

NMR (in CDCl_3):- 3.34(3H,m), 3.4-4.1(6H,m), 4.7(1H,s), 7.2-7.5(10H,m).

- 65 -

EXAMPLE 24Compounds CA to CF

CA A solution of 1-methylimidazole (5.0g) in tetrahydrofuran (70ml) was treated with a solution of lithium diisopropylamide mono-tetrahydrofuran complex in cyclohexane (40ml;1.5M) during 10 minutes under nitrogen, keeping the temperature between -60° and -30°C. The solution was then stirred for 30 minutes, warming to 10°C. The solution was then cooled to -20°C and treated with a solution of 4-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]morpholine (6.15g) in a mixture of tetrahydrofuran (50ml) and 1,4-dioxane (50ml). The solution was stirred at ambient temperature for 6 hours, and then it was treated with dilute hydrochloric acid (100ml;2N) and the aqueous layer was separated. The organic fraction was extracted with water (100ml), the combined aqueous layers were washed with t-butyl methyl ether (100ml), then basified with aqueous sodium hydroxide solution (120ml;2N) and extracted with t-butyl methyl ether (3x200ml). The ether solution was washed with aqueous sodium chloride solution and concentrated under reduced pressure to leave a solid. The solid was recrystallised from methanol, to give 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-1-methyl-

- 66 -

imidazole (4.0g) in the form of a white powder, m.p. 160-163°C.

CB By proceeding in a similar manner to that described above but replacing the 4-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]morpholine by 4-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-morpholine there was prepared 2-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-1-methylimidazole, in the form of a white solid, m.p. 121-123°C, after chromatography on silica gel, eluting with ethyl acetate.

CC By proceeding in a similar manner to that described above but replacing the 4-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]morpholine by 4-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]morpholine there was prepared 2-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]-1-methylimidazole, in the form of a white solid, m.p. 124-126°C, after chromatography on silica gel, eluting with ethyl acetate.

CD By proceeding in a similar manner to that described above but replacing the 1-methylimidazole by 1-[(dimethylamino)methyl]imidazole, there was prepared 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]imidazole, in the form of a white solid, m.p. 186-188°C, from acetonitrile.

CE By proceeding in a similar manner to that described above but replacing the 1-methylimidazole by

- 67 -

1-[(dimethylamino)methyl]imidazole and replacing the 4-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]morpholine by 4-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]-morpholine, there was prepared 2-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]imidazole, m.p. 148-152°C, from butan-2-one.

CF By proceeding in a similar manner to that described above but replacing the 1-methylimidazole by 1-[(dimethylamino)methyl]imidazole and replacing the 4-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]morpholine by 4-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-morpholine, there was prepared 2-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]imidazole, in the form of a white powder, m.p. 188-191°C, from butan-2-one.

EXAMPLE 25

Compounds CG to CL

CG A suspension of 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-1-methylimidazole (2.0g) in ethanol was treated with a solution of sodium borohydride (0.96g) in water (25ml). The mixture was heated at reflux for 1 hour, filtered, and treated with acetone (25ml), followed by dilute hydrochloric acid (200ml; 1N). The pH was adjusted to 7 and the mixture was extracted with t-butyl methyl ether (3x150ml), then dried and concentrated under reduced pressure to leave an oil. Chromatography on silica gel, eluting with a

- 68 -

mixture of ethyl acetate and methanol, gave 2-[4-(4,5-diphenylimidazol-2-ylthio)-1-hydroxybutyl]-1-methylimidazole (1.32g) in the form of a glass [NMR (CDCl_3):- 1.78 (2H,m), 2.09 (2H,m), 2.97 (2H,m), 3.58 (3H,s), 4.83 (1H,dd,J=5Hz & 7Hz), 6.56 (1H,d,J=2Hz), 6.68 (1H,d,J=2Hz), 7.19-7.27 (6H,m), 7.40-7.45 (4H,m)].

CH By proceeding in a similar manner to that described above but replacing the 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-1-methylimidazole by 2-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]-1-methylimidazole, there was prepared 2-[6-(4,5-diphenylimidazol-2-ylthio)-1-hydroxyhexyl]-1-methylimidazole in the form of a glass. [Elemental analysis:- C,69.4; H,6.57;N,12.9;S,7.3%; calculated:- C,69.41;H,6.52; N,12.95;S,7.41%].

CI By proceeding in a similar manner to that described above but replacing the 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-1-methylimidazole by 2-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-1-methylimidazole there was prepared 2-[5-(4,5-diphenylimidazol-2-ylthio)-1-hydroxypentyl]-1-methylimidazole in the form of a glass. [Elemental analysis:- C,67.3;H,6.27;N,12.6;S,7.4%; calculated for $\text{C}_{24}\text{H}_{26}\text{N}_4\text{OS} \cdot 0.5\text{H}_2\text{O}$:- C,7.42;H,6.37;N,13.10;S,7.50%].

- 69 -

CJ By proceeding in a similar manner to that described above but replacing the 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-1-methylimidazole by 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]imidazole there was prepared 2-[4-(4,5-diphenylimidazol-2-ylthio)-1-hydroxybutyl]imidazole in the form of a glass. [Elemental analysis:- C, 65.1; H, 5.71; N, 13.4; S, 7.6%; calculated for $C_{22}H_{22}N_4OS \cdot H_2O$:- C, 64.68; H, 5.92; N, 13.71; S, 7.85%. NMR ($CDCl_3$):- 1.56 (1H, m), 1.66 (1H, m), 1.83 (1H, m), 2.00 (1H, m), 2.71 (1H, m), 2.88 (1H, m), 4.92 (1H, bt, $w_{1/2} = 16\text{Hz}$), 6.64 (2H, s), 7.12-7.22 (6H, m), 7.33-7.40 (4H, m)].

CK By proceeding in a similar manner to that described above but replacing the 2-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]-1-methylimidazole by 2-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]imidazole there was prepared 2-[5-(4,5-diphenylimidazol-2-ylthio)-1-hydroxypentyl]imidazole in the form of a glass. [Elemental analysis:- C, 62.8; H, 5.85; N, 12.7; S, 7.3%; calculated for $C_{23}H_{24}N_4OS \cdot 2H_2O$:- C, 62.70; H, 6.41; N, 12.72; S, 7.28%. NMR ($CDCl_3$):- 1.52 (2H, m), 1.63 (2H, m), 1.94 (1H, m), 2.08 (1H, m), 2.90 (1H, m), 3.06 (1H, m), 5.08 (1H, t, $J = 6\text{Hz}$), 6.08 (2H, s), 7.18-7.30 (6H, m), 7.42 (4H, dd, $J = 7\text{Hz} \ \& \ 2\text{Hz}$)].

CL By proceeding in a similar manner to that described above but replacing the 2-[4-(4,5-diphenyl-

- 70 -

imidazol-2-ylthio)butanoyl]-1-methylimidazole by 2-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]imidazole there was prepared 2-[6-(4,5-diphenylimidazol-2-ylthio)-1-hydroxyhexyl]imidazole in the form of a glass. NMR (CDCl₃):- 1.38-1.53 (4H,m), 1.71 (2H,p,J = 7Hz), 1.81 (1H,m), 1.89 (1H,m), 3.08 (2H,m), 4.75 (1H,dd,J = 7Hz & 5Hz), 6.90 (2H,s), 7.20-7.32 (6H,m), 7.48 (4H,dd, J = 8Hz & 2Hz), 7.63 (1H,s)].

EXAMPLE 26

Compound CM

A solution of morpholine (6.0g) and pyridine (5.6g) in dimethylformamide (10ml) was added during 10 minutes to a stirred solution of 4-chlorobutyryl chloride (9.4g) in dimethylformamide (100ml). The mixture was stirred at ambient temperature for 2 hours and then it was treated with 4,5-diphenylimidazole-2-thiol (15.0g). The mixture was stirred at 125-135°C for 4 hours. After cooling to room temperature, the mixture was poured into dilute aqueous potassium carbonate solution (1 litre) to give a sticky solid. This solid was dissolved in dichloromethane (1 litre), was the resulting solution was washed with water (2x500ml) and dried by filtering through anhydrous sodium sulphate. Concentrating under reduced pressure gave a thick brown oil, which was partitioned between hydrochloric acid (300ml;1N) and toluene (300ml).

- 71 -

The toluene fraction was extracted with hydrochloric acid (200ml;1N) and the combined acidic solution was adjusted to pH4 by treatment with sodium acetate, and was then extracted with toluene (3x200ml). This toluene solution was washed with brine, dried over magnesium sulphate and concentrated under reduced pressure to give a solid. The solid was crystallised from a mixture of t-butyl methyl ether (300ml) and ethanol (150ml) by concentrating to about 200ml and cooling overnight, to give 4-[4-(4,5-diphenylimidazol-2-ylthio)butanoyl]morpholine (10.92g) in the form of colourless crystals, m.p. 168-173°C.

EXAMPLE 27

Compound CN

A solution of morpholine (13.0g) and pyridine (13.0g) in dimethylformamide (50ml) was added during 10 minutes to a stirred solution of 5-chlorovaleryl chloride (22.0g) in dimethylformamide (150ml). The mixture was stirred at ambient temperature for 2 hours then 4,5-diphenylimidazole-2-thiol (37.0g) was added. The mixture was stirred at 125-135°C for 2 hours. After cooling to 80°C, the mixture was poured into water (500ml) and acidified to pH1 by treatment with dilute hydrochloric acid. The mixture was stirred and the resulting solid was filtered off. The filtrate was adjusted to pH4 by treatment with sodium acetate,

- 72 -

to give a sticky solid. This solid was dissolved in dichloromethane (1 litre), was washed with water (500ml), and then dried over magnesium sulphate and concentrated under reduced pressure, to give an oil. The oil was crystallised from t-butyl methyl ether, to give 4-[5-(4,5-diphenylimidazol-2-ylthio)pentanoyl]-morpholine (43.8g), in the form of a white powder, m.p. 134-136°C.

EXAMPLE 28

Compound CO

A solution of 6-(4,5-diphenylimidazol-2-ylthio)-hexanoyl chloride [prepared from 6-(4,5-diphenylimidazol-2-ylthio)hexanoic acid (11.5g) and thionyl chloride] in dichloromethane (50ml) was added dropwise to a solution of morpholine (6.0g) in dichloromethane (150ml), keeping the temperature below 30°C. The mixture was stirred at ambient temperature for 2 hours and was then left overnight. The mixture was washed with hydrochloric acid (100ml;1N), water (100ml), aqueous potassium hydroxide solution (100ml;1N) and with brine (2x50ml), and was then dried over magnesium sulphate. Concentrating under reduced pressure gave a gum, which was triturated with diethyl ether to give 4-[6-(4,5-diphenylimidazol-2-ylthio)hexanoyl]morpholine (9.64g) in the form of an off-white solid, m.p. 120-122°C.

- 73 -

The present invention also includes within its scope pharmaceutical formulations which comprise at least one of the compounds of formula I or a pharmaceutically acceptable salt thereof in association with a pharmaceutically acceptable carrier or coating. In clinical practice the compounds of the present invention may be administered parenterally, rectally or orally.

Solid compositions for oral administration include compressed tablets, pills, powders and granules. In such solid compositions, one or more of the active compounds is, or are, admixed with at least one inert diluent such as starch, sucrose or lactose. The compositions may also comprise, as is normal practice, additional substances other than inert diluents, e.g. lubricating agents, such as magnesium stearate.

Liquid compositions for oral administration include pharmaceutically acceptable emulsions, solutions, suspensions, syrups and elixirs containing inert diluents commonly used in the art such as water and liquid paraffin. Besides inert diluents such compositions may comprise adjuvants, such as wetting and suspending agents, and sweetening, flavouring, perfuming and preserving agents. The compositions according to the invention for oral administration also

- 74 -

include capsules of absorbable material such as gelatin, containing one or more of the active substances with or without the addition of diluents or excipients.

Compositions according to the invention for parenteral administration include sterile aqueous, aqueous-organic, and organic solutions, suspensions and emulsions. Examples of organic solvents or suspending media are propylene glycol, polyethylene glycol, vegetable oils such as olive oil and injectable organic esters such as ethyl oleate. The compositions may also contain adjuvants such as stabilising, preserving, wetting, emulsifying and dispersing agents. They may be sterilised, for example, by filtration through a bacteria-retaining filter, by incorporation in the compositions of sterilising agents, by irradiation or by heating. They may also be manufactured in the form of sterile solid compositions, which can be dissolved in sterile water or some other sterile injectable medium immediately before use.

Solid compositions for rectal administration include suppositories formulated in accordance with known methods and containing at least one compound of formula I or a pharmaceutically acceptable salt thereof.

- 75 -

The percentage of active ingredient in the compositions of the invention may be varied, it being necessary that it should constitute a proportion such that a suitable dosage shall be obtained. Obviously, several unit dosage forms may be administered at about the same time. The size and frequency of the dose employed will be determined by the physician, and depends upon the desired therapeutic effect, the route of administration, the duration of the treatment and the age, sex, size and condition of the patient. In the adult, the doses are generally from 0.01 to 100, preferably 0.1 to 70, more especially 0.5 to 10, mg/kg body weight per day by oral administration, and from 0.001 to 10, preferably 0.01 to 1, mg/kg body weight per day by intravenous administration.

The following Example illustrates a pharmaceutical composition according to the present invention.

COMPOSITION EXAMPLE

No. 2 size gelatin capsules each containing:-

Compound A	20 mg
lactose	100 mg
starch	60 mg
dextrin	40 mg
magnesium stearate	1 mg

were prepared in accordance with the usual procedure.

- 76 -

Capsules can also be made up in a similar manner using any other of the compounds B to CO, or a pharmaceutically acceptable salt thereof.

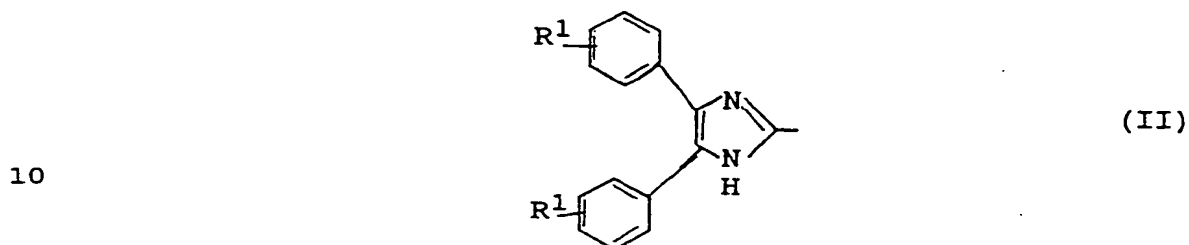
- 77 -

CLAIMS

1. An imidazole derivative of the general formula I:



5 wherein A represents a group of general formula (II):



wherein the symbols R^1 may be the same or different and each represents hydrogen or one or more substituents,

k represents 0, 1 or 2;

15 Q represents a methylene group or alkylene chain containing from 2 to 5 carbon atoms, optionally substituted with one or more alkyl groups containing from 1 to 4 carbon atoms; and

Z represents a hydrogen atom; a hydroxy group; an
 20 optionally substituted alkoxy group; an optionally substituted aryl group; a dialkylamino group wherein the alkyl groups may be the same or different and each is straight- or branched-chain and contains from 1 to 4 carbon atoms; a group of the formula $-NHR^2$, wherein R^2 represents
 25 an acyl group, a group of the formula $-C(SR^3)=N-CN$ wherein R^3 represents a straight- or branched-chain alkyl group containing from 1 to 3 carbon atoms, or R^2 represents a 5- or 6-membered nitrogen-containing heterocyclic ring

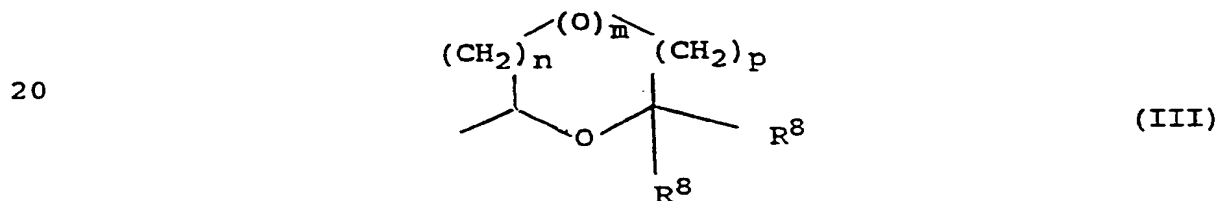
- 78 -

optionally substituted by one or more substituents; or

Z represents a group of the formula $-\text{COR}^4$ wherein R^4 represents a straight- or branched-chain alkyl group containing from 1 to 3 carbon atoms; a group of the formula $-\text{CH}(\text{OH})\text{R}^5$, $-\text{COR}^5$, $-\text{CSR}^5$, $-\text{CONHR}^5$ or $-\text{CSNHR}^5$ wherein R^5 represents a 5- or 6-membered nitrogen-containing heterocyclic ring which may also contain an oxygen atom, optionally substituted by one or more substituents; an alkynyl or cycloalkyl group containing up to 6 carbon atoms; a group of the formula $-\text{CH}(\text{R}^6)\text{OR}^7$ wherein R^6 represents a straight- or branched-chain alkenyl or alkoxy group containing up to 6 carbon atoms and R^7 represents a straight- or branched-chain alkyl group containing from 1 to 4 carbon atoms, optionally substituted by one or more substituents;

or Z represents:

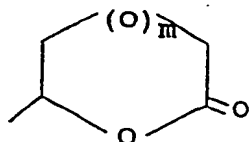
a group of the general formula (III)



25 wherein m is 0 or 1, n is 0 or 1 and p is 1, 2 or 3, and the symbols R^8 each represent a hydrogen atom, or a methyl group substituted by a straight- or branched-chain alkoxy or alkanoyloxy group containing up to 6 carbon atoms;

a group of the general formula (IV)

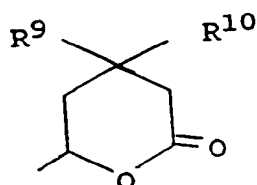
- 79 -



(IV)

5 wherein m is as hereinbefore defined;

a group of the general formula (V)

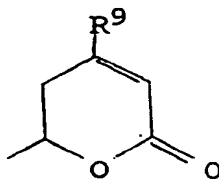


(V)

10

wherein R⁹ represents a hydrogen atom or a straight- or
 branched-chain alkyl group containing from 1 to 4 carbon
 atoms and R¹⁰ represents a hydrogen atom, a hydroxy group
 15 or a straight- or branched-chain alkyl group containing from
 1 to 4 carbon atoms;

a group of the general formula (VI)

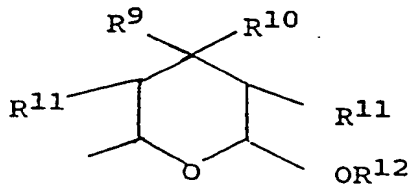


(VI)

20

wherein R⁹ is as hereinbefore defined;

a group of the general formula (VII)



(VII)

25

wherein R⁹ and R¹⁰ are as hereinbefore defined, the symbols

- 80 -

R¹¹ may be the same or different and each represents a hydrogen atom or a hydroxy group and R¹² represents a hydrogen atom or a straight- or branched-chain alkyl group containing from 1 to 4 carbon atoms;

5 or a group of the formula -CH(OH)CH₂(CR⁹R¹⁰)_rCH₂-COR¹³ wherein R⁹ and R¹⁰ are as hereinbefore defined, r represents 0 or 1 and R¹³ represents a hydroxy group or a straight- or branched-chain alkoxy or alkylamino group containing from 1 to 4 carbon atoms;

10 with the exclusion of (2S, 4R, 6S)-6-[4,5-diphenylimidazol-2-yl)-thiomethyl]-4-hydroxy-2-methoxy-3,4,5,6-tetrahydro-2H-pyran and (2R, 4R, 6S)-6-[4,5-diphenylimidazol-2-yl)-thiomethyl]-4-hydroxy-2-methoxy-3,4,5,6-tetrahydro-2H-pyran;

15 or a pharmaceutically acceptable salt thereof.

2. A compound according to claim 1, in which, in the group A, the symbols R¹ may be the same or different and each represents hydrogen or one or more substituents selected from halogen atoms, and straight- or
20 branched-chain alkyl and alkoxy groups containing from 1 to 6 carbon atoms, and trifluoromethyl groups.

3. A compound according to claim 1 or 2, in which Z represents a hydrogen atom; a hydroxy group; an alkoxy group containing 1 to 6 carbon atoms optionally
25 substituted by an alkoxy or alkoxyalkoxy group containing 1 to 6 carbon atoms in each alkoxy moiety; an aryl group optionally substituted by one or more alkoxy groups

- 81 -

containing 1 to 6 carbon atoms; a dialkylamino group wherein the alkyl groups may be the same or different and each is straight- or branched-chain and contains from 1 to 4 carbon atoms; a group of the formula

- 5 -NHR², wherein R² represents a straight- or branched-chain alkanoyl group containing up to 6 carbon atoms and which is optionally substituted by a carboxy group, or R² represents a group of the formula -C(SR³)=N-CN wherein R³ represents a straight- or branched-chain alkyl group containing from 1 to
- 10 3 carbon atoms, or R² represents a 5- or 6-membered nitrogen-containing heterocyclic ring optionally substituted by one or more substituents selected from amino groups and straight- or branched-chain alkyl groups containing from 1 to 3 carbon atoms; and attached to the group NH via a carbon
- 15 atoms; or Z represents a group of the formula -COR⁴ wherein R⁴ represents a straight- or branched-chain alkyl group containing from 1 to 3 carbon atoms; a group of the formula -CH(OH)R⁵, -COR⁵, -CSR⁵, -CONHR⁵ or CSNHR⁵ wherein R⁵ represents a 5- or 6-membered nitrogen-containing
- 20 heterocyclic ring which may also contain an oxygen atom, optionally substituted by one or more substituents selected from straight- or branched-chain alkyl groups containing from 1 to 3 carbon atoms; and alkynyl or cycloalkyl group containing up to 6 carbon atoms; a group of the formula
- 25 -CH(R⁶)OR⁷ wherein R⁶ represents a straight- or branched-chain alkenyl or alkoxy group containing up to 6 carbon atoms and R⁷ represents a straight- or branched-chain alkyl

- 82 -

group containing from 1 to 4 carbon atoms, optionally substituted by one or more substituents selected from hydroxy groups; a group of the general formula (III), (IV), (V), (VI), or (VII) as hereinbefore defined; or a group of the formula $-\text{CH}(\text{OH})\text{CH}_2(\text{CR}^9\text{R}^{10})_r\text{CH}_2\text{COR}^{13}$ as hereinbefore defined.

4. A compound according to any one of the preceding claims in which:

- (i) in the group A, the symbols R^1 may be different or the same and each represents a hydrogen, chlorine or fluorine atom or a straight- or branched-chain alkyl group containing from 1 to 4 carbon atoms, a straight- or branched-chain alkoxy group containing from 1 to 3 carbon atoms, or a trifluoromethyl group;
- (ii) k represents 0;
- (iii) Z represents a hydrogen atom; a hydroxy group; an ethoxy group optionally substituted by a methoxyethoxy group; a phenyl group optionally substituted by one or more alkoxy groups; a dialkylamino group wherein the alkyl groups may be the same or different and each is straight- or branched-chain and contains from 1 to 3 carbon atoms; an ethynyl group, or a cyclohexyl group;
- (iv) Z represents a group $-\text{NHR}^2$, in which R^2 represents a straight- or branched chain alkanoyl group containing up to 6 carbon atoms optionally substituted by a carboxy group; a pyridyl or triazolyl group optionally substituted by one or two substituents selected from amino

- 83 -

groups and straight- or branched-chain alkyl groups;

(v) Z represents a group $\text{-NHC(SR}^3\text{)=N-CN}$, wherein R^3 represents a methyl group;

(vi) Z represents a group -COR^4 wherein R^4 represents a methyl group;

(vii) Z represents a group -CH(OH)R^5 , -COR^5 , -CSR^5 , -CONHR^5 or -CSNHR^5 wherein R^5 represents a imidazolyl, morpholinyl or pyridyl group optionally substituted by one or two alkyl groups;

10 (viii) Z represents a group $\text{-CH(R}^6\text{)OR}^7$, wherein R^6 represents an allyl group, or an alkoxy group containing from 1 to 3 carbon atoms;

(ix) Z represents a group $\text{-CH(R}^6\text{)OR}^7$, wherein R^7 represents an alkyl group containing from 1 to 3 carbon
15 atoms, optionally substituted by a hydroxy group;

(x) Z represents a group of formula (III), in which R^8 represents a hydrogen atom or a hydroxymethyl, methoxymethyl or acetoxymethyl group;

(xi) Z represents a group of formula (V), (VI) or
20 (VII), in which R^9 represents a hydrogen atom or a methyl group;

(xii) Z represents a group of formula (V) or (VII) in which R^{10} represents a hydrogen atom or a hydroxy or methyl group;

25 (xiii) Z represents a group of formula (VII) in which R^{12} represents a hydrogen atom or a methyl group; or

(xiv) Z represents a group of formula

- 84 -

-CH(OH)CH₂(CR⁹R¹⁰)_rCH₂COR¹³ in which R¹³ represents an alkoxy or alkylamino group containing from 1 to 4 carbon atoms.

5. A compound according to any one of the 5 preceding claims which is hereinbefore identified as any one of compounds A to CO.

6. A process for the preparation of a compound according to any one of the preceding claims which comprises:

10 a) where k is 0, reacting a compound of the general formula (VIII)



wherein A is as defined in claim 1, or a salt thereof, of the general formula (IX)

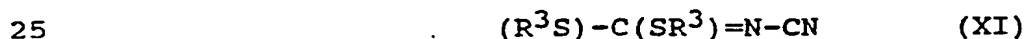


wherein A is as hereinbefore defined in claim 1 and M represents an alkali metal, with a compound of the general formula (X)



20 or a salt thereof, wherein X¹ is a group displaceable by a thiolate salt, and Q and Z are as defined in claim 1;

b) where k is 0 and Z represents a group of the formula -NH-C(SR³)=N-CN, as defined in claim 1, reacting a compound of the general formula (XI)



wherein R³ is as defined in claim 1 with a compound of the general formula (XII)

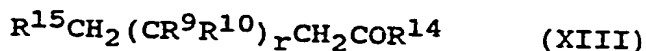
- 85 -



wherein A and Q are as defined in claim 1;

(c) where k is 0 and Z represents a group of the formula $-\text{NHR}^2$ wherein R^2 represents an acyl group, acylating a compound of formula (XII) as hereinbefore defined;

(d) where k is 0 and Z represents a group of the formula $-\text{CH}(\text{OH})\text{CH}_2(\text{CR}^9\text{R}^{10})_r\text{CH}_2\text{COR}^{14}$ wherein R^9 , R^{10} and r are as defined in claim 1 and R^{14} represents a straight- or branched-chain alkoxy group containing from 1 to 4 carbon atoms, reacting a compound of formula (IX) as hereinbefore defined, with a compound of the general formula (XIII)



wherein R^9 , R^{10} , r are as defined in claim 1, R^{14} is as hereinbefore defined and R^{15} represents a 1,2-epoxyethyl group; or

(e) converting a compound of general formula (I) to a further compound of general formula (I);

and, if desired, converting the product thus obtained to a pharmaceutically acceptable salt.

7. A pharmaceutical composition which comprises an imidazole derivative of general formula (I) as defined in claim 1, or a pharmaceutically acceptable salt thereof, in association with a pharmaceutically acceptable carrier or coating.

8. A pharmaceutical composition useful in the treatment of a condition which can be ameliorated by administration of an inhibitor of acyl coenzyme-

- 86 -

A:cholesterol-O-acyl transferase or an inhibitor of the binding of thromboxane TXA_2 to its receptors which comprises an amount effective to ameliorate said condition of an imidazole derivative of general formula I as defined in claim 1 or a pharmaceutically acceptable acid addition salt thereof.

9. A method of treatment of a human or animal host suffering from, or subject to, a condition which can be ameliorated by administration of an inhibitor of acyl coenzyme-A:cholesterol-O-acyl transferase or of an inhibitor of the binding of thromboxane TxA_2 to its receptors which comprises the administration to said host of an imidazole derivative of general formula (I) as defined in claim 1 or a pharmaceutically acceptable acid addition salt.

INTERNATIONAL SEARCH REPORT

of D3

International Application No

PCT/GB 91/00408

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁵ : C 07 D 233/84, A 61 K 31/415, C 07 D 405/12, C 07 D 403/12																				
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 30%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">IPC⁵</td> <td style="padding: 5px;">C 07 D 233/00, A 61 K 31/00, C 07 D 405/00, C 07 D 403/00</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *</div>			Classification System	Classification Symbols	IPC ⁵	C 07 D 233/00, A 61 K 31/00, C 07 D 405/00, C 07 D 403/00														
Classification System	Classification Symbols																			
IPC ⁵	C 07 D 233/00, A 61 K 31/00, C 07 D 405/00, C 07 D 403/00																			
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁸ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category *</th> <th style="border-bottom: 1px solid black;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 10%; border-bottom: 1px solid black;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">EP, A, 0019688 (CIBA-GEIGY AG) 10 December 1980 see the whole document --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-7</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">FR, A, 2380264 (E.I. DU PONT DE NEMOURS AND COMPANY) 8 September 1978 --</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A, 0000353 (CIBA-GEIGY AG) 24 January 1979 --</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A, 0323148 (SMITHKLINE BECKMAN CORP.) 5 July 1989 --</td> <td></td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A, 0005545 (SCHERING AKTIENGESELLSCHAFT) 28 November 1979 -- ./.</td> <td></td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	EP, A, 0019688 (CIBA-GEIGY AG) 10 December 1980 see the whole document --	1-7	A	FR, A, 2380264 (E.I. DU PONT DE NEMOURS AND COMPANY) 8 September 1978 --		A	EP, A, 0000353 (CIBA-GEIGY AG) 24 January 1979 --		A	EP, A, 0323148 (SMITHKLINE BECKMAN CORP.) 5 July 1989 --		A	EP, A, 0005545 (SCHERING AKTIENGESELLSCHAFT) 28 November 1979 -- ./.	
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³																		
X	EP, A, 0019688 (CIBA-GEIGY AG) 10 December 1980 see the whole document --	1-7																		
A	FR, A, 2380264 (E.I. DU PONT DE NEMOURS AND COMPANY) 8 September 1978 --																			
A	EP, A, 0000353 (CIBA-GEIGY AG) 24 January 1979 --																			
A	EP, A, 0323148 (SMITHKLINE BECKMAN CORP.) 5 July 1989 --																			
A	EP, A, 0005545 (SCHERING AKTIENGESELLSCHAFT) 28 November 1979 -- ./.																			
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>																				
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search <div style="text-align: center;">13th June 1991</div> </td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report <div style="text-align: center;">07.08.91</div> </td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;"> International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div> </td> <td style="border-bottom: 1px solid black; padding: 5px;"> Signature of Authorized Officer <div style="text-align: center;"> Natalie Weinberg </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <div style="text-align: center;">13th June 1991</div>	Date of Mailing of this International Search Report <div style="text-align: center;">07.08.91</div>	International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: center;"> Natalie Weinberg </div>														
Date of the Actual Completion of the International Search <div style="text-align: center;">13th June 1991</div>	Date of Mailing of this International Search Report <div style="text-align: center;">07.08.91</div>																			
International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: center;"> Natalie Weinberg </div>																			

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	EP, A, 0043788 (SCHERING AKTIENGESELL- SCHAFT) 13 January 1982 --	
P,X	EP, A, 0372445 (E.I. DU PONT DE NEMOURS AND COMPANY) 13 June 1990 see page 5; figure form. (I); page 6, lines 2,11,17 - page 20; page 9; figures form. 6,7; page 10, lines 39-42 --	1-9
P,X	Patent Abstracts of Japan, volume 14, no. 377 (C-748)(4320), 15 August 1990, & JP, A, 2138263 (NIPPON CHEMIPHAR CO. LTD), 28 May 1990 see the whole document --	1-2,6-7
P,A	EP, A, 0411908 (MERCK & CO. INC.) 6 February 1991 --	
P,A	EP, A, 0391796 (RHONE-POULENC SANTE) 10 October 1990 -----	

Form PCT/ISA 210(extra sheet) (January 1985)

4339w0

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

PCT/GB 91/0040
SA 45505

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01/07/91

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-19688	10-12-80	LU-A- 77703	26-03-79
		AT-B- 360526	12-01-81
		AT-B- 360527	12-01-81
		AU-A- 3778878	10-01-80
		EP-A- 0000353	24-01-79
		EP-A- 0020858	07-01-81
		JP-A- 54016470	07-02-79
FR-A-2380264	08-09-78	US-A- 4182769	08-01-80
		AT-B- 353076	10-07-81
		AU-B- 524360	16-09-82
		AU-A- 3309778	16-08-79
		BE-A- 863758	08-08-78
		CA-A- 1107286	18-08-81
		CH-A- 643834	29-06-84
		DE-A- 2805166	10-08-78
		GB-A- 1587373	01-04-81
		JP-A- 53130665	14-11-78
		LU-A- 79028	25-05-79
		NL-A- 7801454	11-08-78
		SE-A- 7801466	10-08-78
EP-A-353	24-01-79	LU-A- 77703	26-03-79
		AT-B- 360526	12-01-81
		AT-B- 360527	12-01-81
		AU-A- 3778878	10-01-80
		EP-A- 0020858	07-01-81
		EP-A- 0019688	10-12-80
		JP-A- 54016470	07-02-79
EP-A-323148	05-07-89	US-A- 4882348	21-11-89
		AU-A- 2936889	01-08-89
		WO-A- 8906127	13-07-89
		US-A- 4912226	27-03-90
EP-A-5545	28-11-79	DE-A- 2823197	29-11-79
		AU-A- 4737979	29-11-79
		CA-A- 1177836	13-11-84
		FR-A- 2426682	21-12-79
		GB-A, B 2023600	03-01-80

EPO FORM 1/89

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

PCT/GB91/00408
SA 45505

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01/07/91

Page 2

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-5545		JP-A- 54154766	06-12-79
		US-A- 4269847	26-05-81
		US-A- 4355039	19-10-82
		US-A- 4440776	03-04-84
EP-A-43788	13-01-82	DE-A- 3025484	04-02-82
		AU-A- 7249481	07-01-82
		CA-A- 1169063	12-06-84
		JP-B- 2054343	21-11-90
		JP-A- 57075973	12-05-82
		US-A- 4402960	06-09-83
		US-A- 4528298	09-07-85
EP-A-372445	13-06-90	AU-A- 4593089	07-06-90
		CA-A- 2003283	05-06-90
		JP-A- 2237980	20-09-90
EP-A-411908	06-02-91	None	
EP-A-391796	10-10-90	US-A- 5006546	09-04-91

EPO FORM P472

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☒ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

This Page Blank (uspto)